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STAR
AN ABSTRACT JOURNAL

# Scientific and Technical Aerospace Reports

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

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## MATHEMATICAL AND COMPUTER SCIENCES

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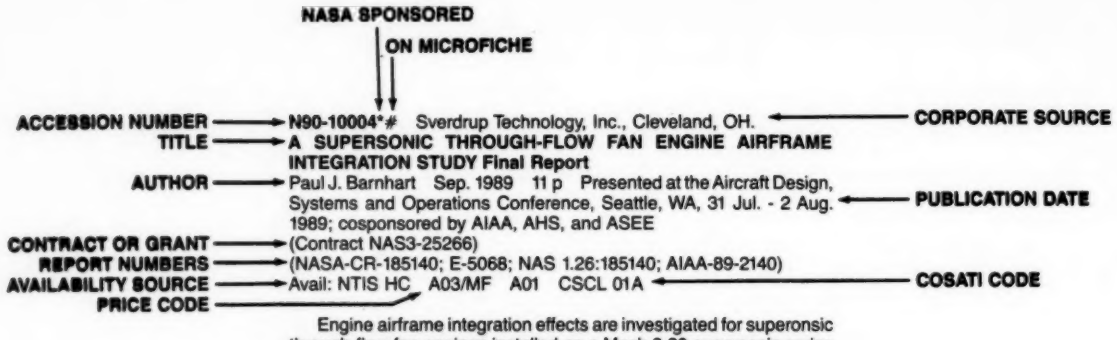
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N90-10004*# Sverdrup Technology, Inc., Cleveland, OH.
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A SUPERSONIC THROUGH-FLOW FAN ENGINE AIRFRAME INTEGRATION STUDY Final Report
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Engine airframe integration effects are investigated for superonsic through-flow fan engines installed on a Mach 3.20 supersonic cruise vehicle. Six different supersonic through-flow fan engine installations covering the effects of engine size, nacelle contour, nacelle placement, and approximate bypass plume effects are presented. The different supersonic through-flow fan installations are compared with a conventional turbine bypass engine configuration on the same basic airframe. The supersonic through-flow fan engine integrations are shown to be comparable to the turbine bypass engine configuration on the basis of installed nacelle wave drag. The supersonic through-flow fan engine airframe integrated vehicles have superior aerodynamic performance on the basis of maximum lift-to-drag ratio than the turbine bypass engine installation over the entire operating Mach number range from 1.10 to 3.20. When approximate bypass plume modeling is included, the supersonic through-flow fan engine configuration shows even larger improvements over the turbine bypass engine configuration. Author

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# Scientific and Technical Aerospace Reports

*A Semimonthly Publication of the National Aeronautics and Space Administration*

## 01 AERONAUTICS (GENERAL)

**N90-23340** Mauter (George A.), Huntington Station, NY.
**AIRCRAFT DRAWINGS INDEX**
George A. Mauter, comp. 1989 68 p
Copyright Avail: George A. Mauter, 268 East Seventeenth Street, Huntington Station, NY 11746

This is an index to a collection of cutaway or 3-view drawings of specific aircraft collected from aviation periodicals by the Fairchild Republic Company Librarian during his tenure there. Drawings of commercial and military aircraft from over 25 countries are indexed. The data elements presented include aircraft designation; name; manufacturer; country; type of drawing; journal title, date and page numbers. Access to this information is provided via two listings: one arranged by aircraft designation and one by name (or NATO codename). This index enables anyone to obtain individual drawings from his library or through inter-library loan.
Author

**N90-23341#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Systems and Logistics.
**ENVIRONMENTAL EFFECTS UPON CROSS-SERVICING OF AIRCRAFT IN NATO M.S. Thesis**
Juan A. DelCastillo Dec. 1989 290 p
(AD-A218374; AFIT/GLM/LSM/89D-14) Avail: NTIS HC A13/MF A02 CSCL 01/5

Cross-servicing of aircraft within NATO is a system established to provide services to aircraft by organizations other than those to which the aircraft are assigned. The ability to provide those services depends on the level of standardization and interoperability within the NATO alliance, and the present diversity of types of aircraft largely restricts the possibility to render those services. The system is regulated by the Standard Agreement 3430 under the field of responsibility of the Military Agency for Standardization (MAS). New factors in the NATO political, economic, and military environment have arisen in the last few years, which added to already existing factors, have produced a situation of increased force requirements with reduced defense budgets and are forcing NATO planners to reassess the whole strategic planning within the alliance. To determine the effects of the new environmental factors on the NATO logistics situation, thus on the diversity of types of aircraft and cross-servicing capabilities, a survey package was sent to the several organizations involved in the management of logistics through out the alliance. The survey answers were statistically analyzed by regional areas, by continent, by organization, and by the condition of civilian or military of the respondents.
GRA

**N90-23342#** Federal Aviation Administration, Washington, DC.
**US CIVIL AIRMEN STATISTICS: CALENDAR YEAR 1989**
1989 35 p Sponsored by Office of Management Systems, Washington, DC
(AD-A220438) Avail: NTIS HC A03/MF A01 CSCL 05/2

FAA Statistical Handbook of Aviation is a convenient source for historical data. It presents statistical information pertaining to the Federal Aviation Administration, the National Airspace System, Airports, Airport Activity, U.S. Civil Air Carrier Fleet, U.S. Civil Air Carrier Operating Data, Airmen, General Aviation Aircraft, Aircraft Accidents, Aeronautical Production and Import/Export. Census of U.S. Civil Aircraft is an annual publication that includes statistical data on the registered civil fleet, air carrier aircraft, and general aviation aircraft-both registered and active, detailed reports for general aviation aircraft by owner's state and county, and registered aircraft by make and model. FAA Air Traffic Activity furnishes terminal and en route air traffic activity information (e.g., takeoffs and landings, flight plans filed) of the National Airspace System. The data is collected/compiled from the FAA-operated Airport Traffic Control Towers, Air Route Traffic Control Centers, Flight Service Stations, Approach Control Facilities, and FAA Contract-towered airports.
GRA

**N90-23343#** Federal Aviation Administration, Washington, DC. Office of Aviation Policy and Plans.
**ECONOMIC VALUES FOR EVALUATION OF FEDERAL AVIATION ADMINISTRATION INVESTMENT AND REGULATORY PROGRAMS Final Report**
Ward Keech, Stefan Hoffer, Calvin Timmerman, and Frank Beradino Oct. 1989 184 p
(AD-A219882; FAA-APO-89-10) Avail: NTIS HC A09/MF A01 CSCL 05/3

Drawing on economic theory, empirical investigations and data from government, private and academic literature, this report revises economic values commonly used by the Federal Aviation Administration (FAA) in the evaluation of investment and regulatory programs. These include the value of time in air travel, the value of a statistical life, unit costs of statistical aviation injuries, aircraft capacity and utilization factors, aircraft variable operating costs, unit replacement and restoration costs of damaged aircraft, weight penalty costs, and probabilities of third-party damage. These values, often referred to as critical values, provide the bases upon which the effectiveness of the aviation system or changes therein may be denominated and assessed in monetary terms. FAA decision making should ideally discriminate among alternative investment and regulatory actions according to whether or not they entail socially and economically acceptable uses of user and general taxes.
GRA

**N90-23344*** National Aeronautics and Space Administration, Washington, DC.
**AERONAUTICAL ENGINEERING: A CONTINUING BIBLIOGRAPHY WITH INDEXES (SUPPLEMENT 251)**
Apr. 1990 147 p
(NASA-SP-7037(251); NAS 1.21:7037(251)) Avail: NTIS HC A07; NTIS standing order as PB90-914100, $11.50 domestic, $23.00 foreign CSCL 01B

This bibliography lists 526 reports, articles, and other documents introduced into the NASA scientific and technical information system in April 1990. Subject coverage includes: design, construction and testing of aircraft and aircraft engines; aircraft components, equipment and systems; ground support systems; and theoretical and applied aspects of aerodynamics and general fluid dynamics.
Author

**N90-23345*** National Aeronautics and Space Administration, Washington, DC.
**AERONAUTICAL ENGINEERING: A CONTINUING BIBLIOGRAPHY WITH INDEXES (SUPPLEMENT 252)**
May 1990 124 p

(NASA-SP-7037(252); NAS 1.21:7037(252)) Avail: NTIS HC A06; NTIS standing order as PB90-914100, $11.50 domestic, $23.00 foreign CSCL 01B

This bibliography lists 425 reports, articles, and other documents introduced into the NASA scientific and technical information system in April 1990. Subject coverage includes: design, construction and testing of aircraft and aircraft engines; aircraft components, equipment and systems; ground support systems; and theoretical and applied aspects of aerodynamics and general fluid dynamics. Author

# 02 AERODYNAMICS

Includes aerodynamics of bodies, combinations, wings, rotors, and control surfaces; and internal flow in ducts and turbomachinery.

For related information see also *34 Fluid Mechanics and Heat Transfer.*

**N90-23346** Pennsylvania State Univ., University Park.
**COMPUTATION OF LOW MACH NUMBER COMPRESSIBLE FLOW Ph.D. Thesis**
Yunho Choi 1989 313 p
Avail: Univ. Microfilms Order No. DA8922033

The computation of compressible flows at very low Mach/Reynolds numbers is studied. It is shown that in the inviscid (or high Reynolds number) case, the difficulties at low Mach numbers arise because of the stiffness of the eigenvalues of the system of governing equations and the singular behavior of the pressure gradient. Two methods are used to circumvent these difficulties. The first, a preconditioning method which premultiplies the time derivative term of the Euler equations by a suitable matrix, is used to control the stiffness of the eigenvalues. This method provides rapid convergence rates independent of Mach number, but its capabilities to deal with the singular bahavior of pressure gradient are limited. The second method, perturbation expansion, is used to introduce pseudo-acoustic speeds which give well-conditioned eigenvalues, and to remove the singular behavior of the pressure gradient. The resulting system of equations can be rendered hyperbolic by introducing artificial time derivatives. Numerical experiments show that the convergence behavior of the perturbed equations is independent of Mach number. Furthermore, the convergence rates observed are characteristic of those obtained for high subsonic Mach number conditions. Extension of computation capabilities to very viscous flows is also considered. It is shown that the requirement that both the inviscid and viscous time-step parameter be of the order of unity prevents convergence in very viscous flows. A time-scaling parameter is introduced to allow the Courant number and Von Neumann number to be order one at low Reynolds numbers. The resulting algorithm gives convergence rates that are independent of both Mach number and Reynolds number. Dissert. Abstr.

**N90-23347** Stanford Univ., CA.
**THREE-DIMENSIONAL STRUCTURE OF PLANE MIXING LAYERS Ph.D. Thesis**
James Horatio Bell 1989 320 p
Avail: Univ. Microfilms Order No. DA8925833

Recent studies have shown the existence of an organized and persistent streamwise vortex structure in plane mixing layers, which is believed to take the form of a row of alternating-sign streamwise vortices. So far, this streamwise vortex structure has been studied mostly through flow-visualization at relatively low Reynolds numbers. The main objective was to obtain quantitative measurements of the streamwise vorticity at Reynolds numbers more comparable to those commonly found in practical applications. In the first experiment, the artificially induced streamwise vortex was observed to decay as approximately 1/X squared within the mixing layer. The effect of the vortex was to locally distort the mean strain distribution in the mixing layer, thus altering the production of the Reynolds stresses. In the second experiment, naturally-occurring streamwise vorticity was clearly observed in a two-stream mixing layer. Concentrated stream wise vortices appeared just downstream of the first roll-up of the spanwise vorticity, with an initial circulation which was roughly half that of the spanwise vortex circulation. The streamwise vortices first appeared in clusters, the position of which seemed to be related to small disturbances in one of the upstream boundary layers. The clusters quickly reorganized into a single row of alternating-sign vortices under the influence of vortex dynamics and changes in the normal stress anisotropy. The streamwise vortex spacing increased in a stepwise fashion, at least partially through the amalgamation of like-sign vortices. Dissert. Abstr.

**N90-23348*#** Scientific Research Associates, Inc., Glastonbury, CT.
**EXTENSION OF A THREE-DIMENSIONAL VISCOUS WING FLOW ANALYSIS**
Bernard C. Weinberg, Shyi-Yaung Chen, Stephen J. Thoren, and Stephen J. Shamroth May 1990 55 p
(Contract NAS1-18140)
(NASA-CR-182023; NAS 1.26:182023; SRA-900049F) Avail: NTIS HC A04/MF A01 CSCL 01A

Three-dimensional unsteady viscous effects can significantly influence the performance of fixed and rotary wing aircraft. These effects are important in both flows about helicopter rotors in forward flight and flows about 3-D (swept and tapered) supercritical wings. A computational procedure for calculating such flow field is developed, and therefore would be of great value in the design process as well as in understanding the corresponding flow phenomena. The procedure is based upon an alternating direction technique employing the Linearized Block Implicit method for solving 3-D viscous flow problems. In order to demonstrate the viability of this method, 2-D and 3-D problems are computed. These include the flow over a 2-D NACA 0012 airfoil under steady and oscillating conditions, and the steady, skewed, 3-D flow on a flat plate. Although actual 3-D flows over wings were not obtained, the ground work was laid for considering such flows. The description of the computational procedure and results are given. Author

**N90-23349#** Nielsen Engineering and Research, Inc., Mountain View, CA.
**A STUDY OF SUPERMANUEVER AERODYNAMICS Final Report, 1 Dec. 1988 - 1 Dec. 1989**
David Nixon and Laura C. Rodman 31 Jan. 1990 76 p
(Contract F49620-88-C-0006; AF Proj. 3005)
(AD-A218378; AFOSR-90-0269TR) Avail: NTIS HC A05/MF A01 CSCL 01/1

The objective is to develop a technique for studying transient separated flows, such as those typical for maneuvering aircraft. The ultimate goal of this research is to develop flow control techniques using the boundary conditions in a Navier Stokes calculation. Once numerical boundary conditions are established, then their physical counterparts may be found. A subdomain technique was developed which allows the study of the effects of various boundary conditions on a local portion of the flowfield. A search technique, using artificial intelligence methods, was developed and was used to find the combination of boundary conditions that achieved the desired flow control. In addition, a two-dimensional boundary conditions theory for the steady Euler and Navier Stokes equations was derived. A wide range of boundary conditions for the subdomains were tried without significant success. However, a boundary condition, based on Duhamel's equation, was found to be very promising in leading to a reduction of computer time. GRA

**N90-23350#** Ballistic Research Labs., Aberdeen Proving Ground, MD.
**PARALLEL COMPUTATION OF SUPERSONIC FLOWS USING A THREE-DIMENSIONAL, ZONAL, NAVIER-STOKES CODE**
Nisheeth R. Patel, Walter B. Sturek, and Glenn A. Smith Nov. 1989 39 p
(DA Proj. 1L1-61102-AH-43)
(AD-A218824; BRL-TR-3049) Avail: NTIS HC A03/MF A01 CSCL 19/10

A three-dimensional, time marching, Navier-Stokes code was developed to solve the flow field around complex geometries using a zonal grid frame-work. The development of the new code is outlined, and the application of the code to compute the flow field about a blunt-nosed, axisymmetric body shape is described. The code extends the computational efficiency of MacCormack's explicit method by incorporating a local variable time-stepping scheme and a new smoothing. Additionally, the code incorporates several features to enhance the convergence rate and minimize the size of the computational grid required for accurate solutions. The computational performance achieved through the efficient utilization of the vector and parallel architecture on the Cray 2 and the Cray Y-MP supercomputers is defined. Comparison of the computations with experimental measurements of surface pressure distribution and boundary layer velocity profiles are presented. GRA

**N90-23351#** Naval Postgraduate School, Monterey, CA. Dept. of Aeronautics and Astronautics.
**FLOWFIELD MEASUREMENTS IN THE WAKE OF A MISSILE AT HIGH ANGLE OF ATTACK M.S. Thesis**
Dan A. Johnson Sep. 1989 74 p
(AD-A219645) Avail: NTIS HC A04/MF A01 CSCL 16/2

The flowfield about a vertically-launched surface to air missile model at an angle of attack of 50 degrees and a Reynolds number of 110,000 was investigated in a low-speed wind tunnel. Determined were the location and intensity of the asymmetric vortices in the wake of the model using planar velocity vector, total pressure coefficient, and vorticity plots. Two model configurations were tested: one at a roll angle of 0 degrees (the + configuration) and the other at a roll angle of 45 degrees (the x configuration). Two flowfield conditions were used: one with no turbulence and the other with turbulence of a length scale on the order of the size of the nose-generated vortices. The following conclusions were reached: the addition of turbulence changed the magnitudes of the variables without changing the patterns in the plots; changing roll angle significantly altered the patterns of the plots; in general, the locations of the vortices as indicated by the velocity plots do not coincide with the centers for the pressure or vorticity plots; and total pressure losses coincide with changes in magnitude of side force as noted in an earlier study. GRA

**N90-23352#** Florida State Univ., Tallahassee. Dept. of Mathematics.
**DESTABILIZATION OF SUPERSONIC FREE SHEAR LAYERS BY PARAMETRIC EXCITATION USING MACH WAVES GENERATED BY A WAVY WALL Final Technical Report, 1 Mar. 1989 - 28 Feb. 1990**
Christopher Tam 28 Feb. 1990 4 p
(Contract N00014-87-J-1130)
(AD-A219655) Avail: NTIS HC A01/MF A01 CSCL 20/1

The original objectives of this research project are: to study and classify all the instability wave and acoustic modes of ducted supersonic free shear layers, and to investigate the possibility of mixing enhancements by means of a periodic Mach wave system generated by wavy walls of the channel enclosure. Some highlights of our findings are: instability and acoustic wave modes of ducted supersonic shear layers; and mixing enhancement by parametric excitation using periodic Mach waves. GRA

**N90-23353#** Naval Postgraduate School, Monterey, CA. Dept. of Aeronautics and Astronautics.
**AN EXPERIMENTAL INVESTIGATION OF SUPPORT STRUT INTERFERENCE ON A THREE-PERCENT FIGHTER MODEL AT HIGH ANGLES OF ATTACK M.S. Thesis**
John D. Sommers Sep. 1989 147 p
(AD-A219793) Avail: NTIS HC A07/MF A01 CSCL 01/3

A low-speed wind-tunnel investigation was conducted to examine the aerodynamic interference caused by support struts on a three-percent scale model of the YF-17 lightweight fighter prototype. The study was undertaken at the request of the NASA-Ames Research Center to obtain background data in support of an upcoming investigation in which a full-scale F/A-18 will be mounted in the 80 x 120 foot wind tunnel. Force and moment measurements were made for various strut configurations using a precision six-component strain gage balance. Flow visualization studies were also conducted using smoke injected upstream of the model and illuminated by a laser sheet to highlight flow phenomenon around the model. Results of the investigation indicate that only minor aerodynamic interference was caused by the strut configuration tested. Of the configurations tested, it was determined by a subjective analysis that a slight reduction in interference could be realized by attaching the forward struts to the wing tips and the aft strut to the tail hook pivot point. GRA

**N90-23354#** Universal Energy Systems, Inc., Dayton, OH.
**THE 3-D COMPOSITE VELOCITY SOLUTIONS FOR SUBSONIC/TRANSONIC FLOW OVER FOREBODIES AND AFTERBODIES Final Report, Feb. - Nov. 1989**
Raymond E. Gordnier Nov. 1989 56 p
(Contract F33615-86-D-3800; AF Proj. 2307)
(AD-A220370; WRDC-TR-89-3107) Avail: NTIS HC A04/MF A01 CSCL 20/4

A composite velocity procedure for the three-dimensional reduced Navier-Stokes equations is developed. In the spirit of matched asymptotic expansions, the velocity components are written as a combined multiplicative and additive composite of viscous like velocities (U, W) and pseudo-potential or inviscid velocities (phi sub x, phi sub y, phi sub z). The solution procedure is then consistent with both asymptotic inviscid flow and boundary layer theory. For transonic flow cases, the Enquist-Osher flux biasing scheme developed for the full potential equation is used. A quasi-conservation form of the governing equation is used in the shock region to capture the correct rotational behavior. This is combined with the standard nonconservation nonentropy generating form used in nonshock regions. The consistent strongly implicit procedure is coupled with plane relaxation to solve the discretized equations. The composites velocity procedure is coupled with plane relaxation to solve the discretized equations. The composites velocity procedure applied for the solution of three-dimensional afterbody problems. GRA

**N90-23355#** Air Force Geophysics Lab., Hanscom AFB, MA. Ionospheric Physics Div.
**PROCEEDINGS OF WORKSHOP ON ATMOSPHERIC DENSITY AND AERODYNAMIC DRAG MODELS FOR AIR FORCE OPERATIONS, VOLUME 1 Interim Scientific Report**
Frank A. Marcos, ed. 13 Feb. 1990 316 p Workshop held in Hanscom AFB, MA, 20-22 Oct. 1987
(AD-A220381; GL-TR-90-0033-Vol-1; ERP-1053-Vol-1) Avail: NTIS HC A14/MF A02 CSCL 01/1

The major objective was to assess the capability for significant improvement in models of absolute density, winds, temperature and composition. Emphasis was focused on the altitude region 80 to 250 km. Papers were presented in the following areas: Air Force requirements, physics of density and drag variability. A set of recommendations for improved modeling capabilities was developed by the participants. GRA

**N90-23356#** Air Force Geophysics Lab., Hanscom AFB, MA. Ionospheric Physics Div.
**PROCEEDINGS OF WORKSHOP ON ATMOSPHERIC DENSITY AND AERODYNAMIC DRAG MODELS FOR AIR FORCE OPERATIONS, VOLUME 2 Interim Scientific Report**
Frank A. Marcos, ed. 13 Feb. 1990 397 p Workshop held in Hanscom AFB, MA, 20-22 Oct. 1987
(AD-A220382; GL-TR-90-0033-Vol-2; ERP-1053-Vol-2) Avail: NTIS HC A17/MF A03 CSCL 01/1

The major objective was to assess the capability for significant improvement in models of absolute density, winds, temperature and composition. Emphasis was focused on the altitude region 80 to 250 km. Papers were presented in the following areas: empirical models, thermospheric general circulation models, new density and drag measurement techniques (direct and remote sensing), aerodynamic drag coefficients, and solar and magnetospheric

inputs. A set of recommendations for improved modeling capabilities was developed by the participants. GRA

**N90-23357#** Air Force Armament Lab., Eglin AFB, FL. Aerodynamics Branch.
**A NEW STRESS ROUTINE FOR THE PROJECTILE DESIGN ANALYSIS SYSTEM (PRODAS) Report, Sep. 1988 - Sep. 1989**
Kurt G. Gothe Mar. 1990 26 p Presented at the 40th Meeting of the Aeroballistic Range Association, Paris, France, Sep. 1989
(AF Proj. 2567)
(AD-A220564; AFATL-TP-90-06) Avail: NTIS HC A03/MF A01 CSCL 12/5

The purpose of this paper is to describe and discuss results obtained from a new stress routine, which is implemented in the Projectile Design Analysis System (PRODAS). This system is regularly used by the Aerodynamics Branch (FXA), AFATL, Eglin AFB, FL, to design projectiles and to predict the aerodynamic behavior and performance of projectiles and rockets prior to testing in the Aeroballistic Research Facility. Due to the increasing variety of aerodynamic configurations that are being tested, a stress routine was desired which provides the model/sabot designer with a good estimation of projectile stress during the launch phase. GRA

**N90-23358#** Naval Surface Warfare Center, Dahlgren, VA.
**NONAXISYMMETRIC BODY, SUPERSONIC, INVISCID DYNAMIC DERIVATIVE PREDICTION Final Report**
Leroy Devan Jun. 1989 46 p
(AD-A220839; NSWC-TR-89-99) Avail: NTIS HC A03/MF A01 CSCL 20/4

A supersonic, aerodynamic computational model, which is the basis of the NANC code, has been extended to compute dynamic derivatives. The extension is to the inviscid contribution of constant angular rates and axial accelerations. The body geometry limitations are the same as for the steady-state model. Here, a pointed body or equivalent pointed body is assumed for low Mach numbers; at higher Mach numbers, the effect of axial acceleration is neglected and the body may be blunt. The body may be noncircular with planar discontinuities, including inlets, with fins (up to six per fin set), which lie on a cylindrical coordinate ray. For the low Mach number range, the original second-order potential model has been extended for angular rate derivative prediction. For the acceleration rate derivatives, a hybrid first- and second-order model has been developed. For the high Mach number range, an equivalent angle-of-attack vector is defined and combined with local solution models. Computational comparisons are made with experimental data, primarily for pitch and roll damping derivatives. GRA

**N90-23359#** Centro Italiano Ricerche Aerospaziali, Naples.
**A COMPUTER CODE FOR THE PREDICTION OF AERODYNAMIC CHARACTERISTICS OF LIFTING AIRFOILS AT TRANSONIC SPEED**
Domenico P. Coiro, P. P. DeMatteis, and M. Amato 10 May 1989 10 p Presented at GAMNI/SMAI-IMA, Antibes, France, 17-19 May 1989
(DLC-EST-TN-030; ETN-90-96560) Avail: NTIS HC A02/MF A01

The capability of computing aerodynamic performances of airfoils in subcritical and supercritical conditions is presented. Inviscid solution was obtained using a finite volume 4th order Runge-Kutta explicit time-stepping scheme. Turbulent boundary layer was solved using Green or Whitfield integral methods in inverse form. Results are shown graphically. The influence of gridspacing, boundary layer method, artificial viscosity, and interaction procedure is under investigation. ESA

**N90-23360#** Centro Italiano Ricerche Aerospaziali, Naples.
**PREDICTION OF AERODYNAMIC PERFORMANCE OF AIRFOILS IN LOW REYNOLDS NUMBER FLOWS**
Domenico P. Coiro and Carlo deNicola 28 May 1989 12 p Presented at Low Reynolds Number Flows Congress, Notre Dame, IN, Jun. 1989
(DLC-EST-TN-031; ETN-90-96561) Avail: NTIS HC A03/MF A01

A viscous/inviscid interaction procedure for the solution of incompressible flowfields with large laminar separated regions is presented, based on the approach previously followed for the prediction of the performances of airfoils up to stall conditions. The extension of the interaction procedure to take into account the existence of laminar separation bubbles is described, with an eye toward the question of the numerical determination of the transition. The application of the computational procedure for two airfoils widely investigated experimentally at low Reynolds number is discussed; numerical results show the reliability of the method in these conditions. A critical analysis of the solutions indicates the guidelines for the future improvements of the method. ESA

**N90-23361#** Centro Italiano Ricerche Aerospaziali, Naples. Computational Labs.
**HYPERSONIC AERODYNAMICS OF SPACECRAFT**
A. Mattei and G. Russo 2 Apr. 1989 35 p Presented at EUROMECH Colloquium No. 246 Special Session on European Developments in Hypersonic Aerodynamics, Turin, Italy, 3-7 Apr. 1989
(DLC-EST-TD-032; ETN-90-96562) Avail: NTIS HC A03/MF A01

The Italian aerospace research center CIRA is described. Activities of computational, experimental aerodynamic, and technological laboratories are detailed. The space scenario and studies in hypersonics and aerothermodynamics are outlined. The development of a facility capable of testing and qualifying the thermal protection system of Hermes, called the plasma wind tunnel, is described. Other involvements of CIRA are included. ESA

**N90-23362#** Centro Italiano Ricerche Aerospaziali, Naples.
**CODICE ETF-3D: EULER TRANSONIC FLOW USER MANUAL [MANUALE DUSO DEL CODICE ETF 3D]**
S. Borrelli 23 Mar. 1989 40 p In ITALIAN
(DLC/FLU-INT-TN-006; ETN-90-96563) Avail: NTIS HC A03/MF A01

A user manual for the coding of three dimensional Euler Transonic Flow (ETF) is presented, as an instrument for numerical investigation of nonviscous compressible flow fields in three dimensional transonic aerodynamic applications. Mach numbers below 1.5 to 1.8 are considered. Input and output post-processing are explained. ESA

**N90-23363#** Aeronautical Research Inst. of Sweden, Stockholm. Dept. of Aerodynamics.
**LOW SPEED TESTING OF A LAMINAR FLOW AIRFOIL IN AN ADAPTIVE WALL WIND TUNNEL**
F. Khadjavi Nov. 1989 97 p Sponsored by Swedish Board for Technical Development
(FFA-TN-1989-08; ETN-90-96599) Avail: NTIS HC A05/MF A01

A natural laminar flow (NLF) airfoil was tested in a low speed wind tunnel for cruise flight condition at Reynolds numbers up to 10 million. To achieve such high numbers a large scale model was used, causing large wall interference effects during testing. A two dimensional flexible wall test section was used to reduce interference effects. The NLF0414 model was tested with both straight and adapted walls, and results compared with those of the NASA Langley Research Center. Computations show that by increasing the length of the laminar run on the pressure side and reducing the length of the laminar run on the suction side, the profile drag would decrease and the width of the low drag bucket would increase. ESA

**N90-23364#** Aeronautical Research Inst. of Sweden, Stockholm. Dept. of Aerodynamics.
**EULER CODE PREDICTED SEPARATION AT THE AIRFOIL TRAILING EDGE**
Anders Holmberg 20 Nov. 1989 26 p

(Contract FMV-82260-88-061-73-001)
(FFA-TN-1989-30; ETN-90-96601) Avail: NTIS HC A03/MF A01

The transition from trailing edge separation to upper side separation flow is investigated. A modified NACA0012 standard airfoil, with a rounded trailing edge is used. The influence from the artificial damping coefficient (artificial viscosity) and mesh density is investigated. A potential flow solver is developed in order to be used as a tool to examine the uniqueness of the solution of the discretized Euler equations. The Euler code at small coefficient values and/or a dense mesh at the trailing edge is shown to make the flow leave the symmetric airfoil (with a round trailing edge) at the symmetric plane. ESA

**N90-23365#** Aeronautical Research Inst. of Sweden, Stockholm. Dept. of Aerodynamics.
**PRESSURE MEASUREMENTS ON A 5.35 m HAWT IN CARDC 12 X 16 m WIND TUNNEL COMPARED TO THEORETICAL PRESSURE DISTRIBUTIONS**
Goeran Ronsten, Jan-Aake Dahlberg, Staffan Meijer, He Dexin, and Chen Ming (Chinese Aerodynamic Research and Development Center, Mianyang.) Nov. 1989 10 p Presented at EWEC 1989, Glasgow, Scotland, 1989
(Contract STEV-506-266-3)
(FFA-TN-1989-46; ETN-90-96603) Avail: NTIS HC A02/MF A01

In order to investigate the difference between calculated and measured loads on a wind turbine, a wind tunnel test was performed at CARDC Low Speed Aerodynamics Institute (China). Pressure distributions on a 5.35 m diameter Horizontal Axis Wind Turbine (HAWT) were measured at 8 radial stations at Reynolds numbers ranging from 4 x 10(exp 5) to 1.2 x 10(exp 6). The measured radial thrust distribution shows higher loading at the root when compared to theoretical flow leave calculations while the tip is less loaded. The maximum power is underpredicted by the blade element/momentum theory while the power at high tip speed ratios is overpredicted. The total thrust force is overpredicted at high tip speed ratios .The total thrust measured with a six component balance and with pressure transducers agrees well. ESA

**N90-23366*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**MULTIPROCESSING ON SUPERCOMPUTERS FOR COMPUTATIONAL AERODYNAMICS**
Maurice Yarrow (Sterling Federal Systems, Inc., Palo Alto, CA.) and Unmeel B. Mehta May 1990 38 p Presented at the 28th Aerospace Sciences Meeting, Reno, NV, 8-11 Jan. 1990 Revised Original contains color illustrations
(NASA-TM-102806; A-90121; NAS 1.15:102806; AIAA-90-0337) Avail: NTIS HC A03/MF A01; 5 functional color pages CSCL 01A

Very little use is made of multiple processors available on current supercomputers (computers with a theoretical peak performance capability equal to 100 MFLOPs or more) in computational aerodynamics to significantly improve turnaround time. The productivity of a computer user is directly related to this turnaround time. In a time-sharing environment, the improvement in this speed is achieved when multiple processors are used efficiently to execute an algorithm. The concept of multiple instructions and multiple data (MIMD) through multi-tasking is applied via a strategy which requires relatively minor modifications to an existing code for a single processor. Essentially, this approach maps the available memory to multiple processors, exploiting the C-FORTRAN-Unix interface. The existing single processor code is mapped without the need for developing a new algorithm. The procedure for building a code utilizing this approach is automated with the Unix stream editor. As a demonstration of this approach, a Multiple Processor Multiple Grid (MPMG) code is developed. It is capable of using nine processors, and can be easily extended to a larger number of processors. This code solves the three-dimensional, Reynolds averaged, thin-layer and slender-layer Navier-Stokes equations with an implicit, approximately factored and diagonalized method. The solver is applied to generic oblique-wing aircraft problem on a four processor Cray-2 computer. A tricubic interpolation scheme is developed to increase the accuracy of coupling of overlapped grids. For the oblique-wing aircraft problem, a speedup of two in elapsed (turnaround) time is observed in a saturated time-sharing environment. Author

# 03 AIR TRANSPORTATION AND SAFETY

Includes passenger and cargo air transport operations; and aircraft accidents.

For related information see also *16 Space Transportation* and *85 Urban Technology and Transportation.*

**N90-23367#** General Accounting Office, Washington, DC.
**AVIATION SECURITY: CORRECTIVE ACTIONS UNDERWAY, BUT BETTER INSPECTION GUIDANCE STILL NEEDED. REPORT TO THE CHAIRWOMAN, GOVERNMENT ACTIVITIES AND TRANSPORTATION SUBCOMMITTEE, COMMITTEE ON GOVERNMENT OPERATIONS, HOUSE OF REPRESENTATIVES**
Aug. 1988 30 p
(GAO/RCED-88-160) Avail: NTIS HC A03/MF A01

This report presents the Federal Aviation Administration's (FAA) findings, conclusions, and recommendations regarding the effectiveness of FAA's inspections in identifying and rectifying security deficiencies. It was prepared for the Subcommittee on Government Activities and Transportation of the House of Representatives Committee on Government Operations. Author

**N90-23368#** Systems Control Technology, Inc., Arlington, VA.
**AERONAUTICAL DECISIONMAKING FOR AIR AMBULANCE PROGRAM ADMINISTRATORS Final Report**
R. J. Adams and E. D. McConkey Washington, DC FAA Feb. 1990 20 p
(Contract DTFA01-87-C-00014)
(DOT/FAA/DS-88/8) Avail: NTIS HC A03/MF A01

This manual discusses five of the most critical administrative aeronautical decision areas. The treatment is brief to ensure that the important, basic aeronautical limits will be read and understood by the largest possible audience. The concerns are: accident characteristics, pilot characteristics, weather restrictions, training needs, and risk management. Each of these concerns is discussed in a summary format. The summaries begin with a concise statement of the problem. The statement is followed by a discussion of the governing regulations, an explanation of the underlying reasons for the limitation, and recommended solutions an administrator could implement to reduce the impact of, or eliminate, the risk. This summary material is supplemented by appropriate references for use by the reader who would like to explore on or more of these areas in greater detail. This administrator's manual is one of an integrated set of five Aeronautical Decisionmaking (ADM) manuals developed by the Federal Aviation Administration in a concerted effort to reduce the number of human factor related helicopter accidents. It can be used as one element of a comprehensive program for improving safety, reducing risk, and, hopefully, the high cost of helicopter hull and liability insurance. Author

**N90-23369#** Federal Aviation Administration, Atlantic City, NJ.
**FIRE HAZARDS OF AEROSOL CANS IN AIRCRAFT CARGO COMPARTMENTS Final Report**
David R. Blake Dec. 1989 24 p Original contains color illustrations
(DOT/FAA/CT-89/32) Avail: NTIS HC A03/MF A01; 4 functional color pages

Some hazards associated with aerosol cans involved in cargo fires were determined. Over the last several years the chlorofluorocarbon propellant used in aerosol cans has been replaced with hydrocarbons such as butane, propane, and isobutane. These flammable gases would normally be prohibited on passenger carrying airplanes but there is an exception for up to 75 ounces per person for medicinal and toilet articles when

carried in checked baggage only. Seven fire tests involving aerosol cans were conducted in an 800-cubic-foot cargo compartment. The main conclusions of the study were that hydrocarbon propellants in aerosol cans increase the damage potential of luggage fires; the fires in a simulated Class D compartment where aerosol cans ruptured and ignited were not contained; a Class C compartment provides significantly more protection against aerosol can fire threat than does a Class D compartment; an aerosol can rupturing and igniting in a Class D or Class C cargo compartment would eliminate the compartment's ability to control ventilations and drafts; and aerosol cans would be exposed to elevated temperatures for a longer period of time in a luggage fire in a Class D compartment than in a Class C compartment. Author

**N90-23370*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**PERSONALITY FACTORS IN FLIGHT OPERATIONS. VOLUME 1: LEADER CHARACTERISTICS AND CREW PERFORMANCE IN A FULL-MISSION AIR TRANSPORT SIMULATION**
Thomas R. Chidester, Barbara G. Kanki, H. Clayton Foushee, Cortlandt L. Dickinson, and Stephen V. Bowles (California Professional School for Psychology, Berkeley.) Apr. 1990 46 p
(NASA-TM-102259; A-90018; NAS 1.15:102259) Avail: NTIS HC A03/MF A01 CSCL 05I

Crew effectiveness is a joint product of the piloting skills, attitudes, and personality characteristics of team members. As obvious as this point might seem, both traditional approaches to optimizing crew performance and more recent training development highlighting crew coordination have emphasized only the skill and attitudinal dimensions. This volume is the first in a series of papers on this simulation. A subsequent volume will focus on patterns of communication within crews. The results of a full-mission simulation research study assessing the impact of individual personality on crew performance is reported. Using a selection algorithm described in previous research, captains were classified as fitting one of three profiles along a battery of personality assessment scales. The performances of 23 crews led by captains fitting each profile were contrasted over a one-and-one-half-day simulated trip. Crews led by captains fitting a positive Instrumental-Expressive profile (high achievement motivation and interpersonal skill) were consistently effective and made fewer errors. Crews led by captains fitting a Negative Expressive profile (below average achievement motivation, negative expressive style, such as complaining) were consistently less effective and made more errors. Crews led by captains fitting a Negative Instrumental profile (high levels of competitiveness, verbal aggressiveness, and impatience and irritability) were less effective on the first day but equal to the best on the second day. These results underscore the importance of stable personality variables as predictors of team coordination and performance. Author

**N90-23371#** Civil Aeromedical Inst., Oklahoma City, OK.
**THE INFLUENCE OF ADJACENT SEATING CONFIGURATIONS ON EGRESS THROUGH A TYPE 3 EMERGENCY EXIT Final Report**
Paul G. Rasmussen and Charles B. Chittum Dec. 1989 22 p
Sponsored by FAA, Washington, DC
(AD-A218393; DOT/FAA/AM-89/14) Avail: NTIS HC A03/MF A01 CSCL 01/3

When the United Kingdom Civil Aviation Authority (CAA) established a mandatory action intended to improve access to, and opening of, Type 3 emergency exits, the Northwest Mountain Region identified a need for a study to evaluate the proposed changes against existing minimum requirements of the Federal Aviation Regulations (FAR). The results indicate that the proposed CAA configuration and the alternative configuration were both more effective than the minimum configuration required by the FARs as measured by evacuation flow rate. There were no significant differences in the exit preparation time among the four seating arrangements. GRA

**N90-23372#** Army Aviation Systems Command, Saint Louis, MO.
**PEACETIME REPLACEMENT AND CRASH DAMAGE FACTORS FOR ARMY AIRCRAFT Final Report, 1975 - 1988**
Robert L. Benson May 1989 90 p
(AD-A218544; USAAVACOM-TR-89-F-2) Avail: NTIS HC A05/MF A01 CSCL 01/2

Army aircraft mishaps are among the highest concerns of Army management. The Army invests significant amounts of money into training aviators. The Worldwide Aviation Logistics Conference (WALC) meets annually at the U.S. Army Aviation Systems Command (USAAVSCOM) in St. Louis, Missouri. One of the issues that the WALC addresses is safety. The WALC uses factors to assess probable accident rates for proposed flying levels. The Peacetime Replacement Factor (PTRF) relates flying hours to the expected number of aircraft losses. The Crash Damage (CD) Factor relates flying hours to the expected number of crash damaged aircraft. Flying hours are expressed in a per 100,000 basis. Annual updates are made to these factors by the Operational Systems Analysis Division of the Directorate for Systems and Cost Analysis at AVSCOM. GRA

**N90-23373*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**ANALYSIS OF SEQUENCING AND SCHEDULING METHODS FOR ARRIVAL TRAFFIC**
Frank Neuman and Heinz Erzberger Apr. 1990 47 p
(NASA-TM-102795; A-90086; NAS 1.15:102795) Avail: NTIS HC A03/MF A01 CSCL 01C

The air traffic control subsystem that performs scheduling is discussed. The function of the scheduling algorithms is to plan automatically the most efficient landing order and to assign optimally spaced landing times to all arrivals. Several important scheduling algorithms are described and the statistical performance of the scheduling algorithms is examined. Scheduling brings order to an arrival sequence for aircraft. First-come-first-served scheduling (FCFS) establishes a fair order, based on estimated times of arrival, and determines proper separations. Because of the randomness of the traffic, gaps will remain in the scheduled sequence of aircraft. These gaps are filled, or partially filled, by time-advancing the leading aircraft after a gap while still preserving the FCFS order. Tightly scheduled groups of aircraft remain with a mix of heavy and large aircraft. Separation requirements differ for different types of aircraft trailing each other. Advantage is taken of this fact through mild reordering of the traffic, thus shortening the groups and reducing average delays. Actual delays for different samples with the same statistical parameters vary widely, especially for heavy traffic. Author

**N90-23374*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**SIMULATOR EVALUATION OF THE FINAL APPROACH SPACING TOOL**
Thomas J. Davis, Heinz Erzberger, and Steven M. Green May 1990 18 p
(NASA-TM-102807; A-90122; NAS 1.15:102807) Avail: NTIS HC A03/MF A01 CSCL 01C

The design and simulator evaluation of an automation tool for assisting terminal radar approach controllers in sequencing and spacing traffic onto the final approach course is described. The automation tool, referred to as the Final Approach Spacing Tool (FAST), displays speed and heading advisories for arrivals as well as sequencing information on the controller's radar display. The main functional elements of FAST are a scheduler that schedules and sequences the traffic, a 4-D trajectory synthesizer that generates the advisories, and a graphical interface that displays the information to the controller. FAST was implemented on a high performance workstation. It can be operated as a stand-alone in the Terminal Radar Approach Control (TRACON) Facility or as an element of a system integrated with automation tools in the Air Route Traffic Control Center (ARTCC). FAST was evaluated by experienced TRACON controllers in a real-time air traffic control

simulation. Simulation results show that FAST significantly reduced controller workload and demonstrated a potential for an increase in landing rate. Author

**N90-23375#** Technische Univ., Brunswick (Germany, F.R.).
**RESULTS OF TCAS-2 SIMULATIONS IN RECONSTRUCTED DANGEROUS ENCOUNTERS (JUL. 1986 TO JUN. 1989) [ERGEBNISSE DER TCAS-2 SIMULATIONEN IN REKONSTRUIERTEN GEFAEHRLICHEN BEGEGNUNGEN (7/86 BIS 6/89)]**
Andreas Herber Jul. 1989 97 p In GERMAN
(ETN-90-96474) Avail: NTIS HC A05/MF A01

Experiments of traffic departures in controlled air lanes considered dangerous by the federal administration are carried out to test the efficiency of a collision protection system. Validation or modification of the system design is addressed. The high contribution of adverse vertical operations is difficult for a system with linear extrapolation after the conflict recognition by TCAS. In about a quarter of the examined cases a variation of the vertical velocity of 500 fpm or more arises. Combination of TCAS2 -traffic aeroplane - Rode C - flight aeroplane seems to be a good solution for sure and operational encounters. ESA

# 04 AIRCRAFT COMMUNICATIONS AND NAVIGATION

Includes digital and voice communication with aircraft; air navigation systems (satellite and ground based); and air traffic control.

For related information see also *17 Space Communications, Spacecraft Communications, Command and Tracking* and *Communications and Radar.*

**N90-23376*#** Georgia Inst. of Tech., Atlanta. School of Aerospace Engineering.
**OPTIMAL HELICOPTER TRAJECTORY PLANNING FOR TERRAIN FOLLOWING FLIGHT Final Report**
P. K. A. Menon Mar. 1990 194 p
(Grant NAG2-463)
(NASA-CR-186470; NAS 1.26:186470) Avail: NTIS HC A09/MF A01 CSCL 17G

Helicopters operating in high threat areas have to fly close to the earth surface to minimize the risk of being detected by the adversaries. Techniques are presented for low altitude helicopter trajectory planning. These methods are based on optimal control theory and appear to be implementable onboard in realtime. Second order necessary conditions are obtained to provide a criterion for finding the optimal trajectory when more than one extremal passes through a given point. A second trajectory planning method incorporating a quadratic performance index is also discussed. Trajectory planning problem is formulated as a differential game. The objective is to synthesize optimal trajectories in the presence of an actively maneuvering adversary. Numerical methods for obtaining solutions to these problems are outlined. As an alternative to numerical method, feedback linearizing transformations are combined with the linear quadratic game results to synthesize explicit nonlinear feedback strategies for helicopter pursuit-evasion. Some of the trajectories generated from this research are evaluated on a six-degree-of-freedom helicopter simulation incorporating an advanced autopilot. The optimal trajectory planning methods presented are also useful for autonomous land vehicle guidance. Author

**N90-23377#** Federal Aviation Administration, Atlantic City, NJ.
**AN EVALUATION OF THE ACCURACY OF A MICROWAVE LANDING SYSTEM AREA NAVIGATION SYSTEM AT MIAMI/TAMIAMI FLORIDA AIRPORT Technical Report, Nov. 1989**
Clifford W. Mackin Mar. 1990 22 p
(Contract T0604L)
(DOT/FAA/CT-TN89/40) Avail: NTIS HC A03/MF A01

A series of flight tests were performed by the Federal Aviation Administration (FAA) Technical Center at the Miami/Tamiami Florida Airport to demonstrate the operation and capabilities of a prototype Microwave Landing System (MLS) Area Navigation System (RNAV). The Technical Center's test bed MLS was transported to and collocated with the commissioned Category 1 Instrument Landing System (ILS) on runway 9R at Tamiami. The flight data collected indicate that the errors in aircraft position, as computed by the MLS RNAV algorithm, consistently met Category 1 performance criteria, and that computed centerline and glide slope operations can be conducted with Category 1 accuracies to runways with lateral offsets of up to 3500 feet. Author

**N90-23378#** Federal Aviation Administration, Atlantic City, NJ.
**MLS MATHEMATICAL MODEL VALIDATION STUDY USING AIRBORNE MLS DATA FROM MIDWAY AIRPORT ENGINEERING FLIGHT TESTS, AUGUST 1988 Technical Report, Mar. 1989**
Linda Pasquale and Jesse D. Jones Apr. 1990 42 p
(Contract T06-038)
(DOT/FAA/CT-TN90/2) Avail: NTIS HC A03/MF A01

The Microwave Landing System (MLS) mathematical model validation study evaluated the performance of the MLS math model by comparing the results of the model's simulation of flight test profiles flown at Midway Airport in Chicago with actual airborne data collected during the test flights. The study specifically addressed the problems of scattering and shadowing of MLS signals by buildings in the airport environment. Comparisons of model output with real world data showed good agreement. Discrepancies between the two were explainable as either the model's sensitivity to input parameters or the model's worst case scenario strategy. The conclusion is supported that the MLS math model is a valuable tool for use in the evaluation of potential sources of signal interference for an MLS system configuration in a particular airport environment. Author

**N90-23379#** Federal Aviation Administration, Atlantic City, NJ.
**POSITION COMPUTATION WITHOUT ELEVATION INFORMATION FOR COMPUTED CENTERLINE OPERATIONS Technical Report, Aug. 1989**
Barry R. Billman and Christopher J. Wolf Apr. 1990 23 p
(Contract T0707A)
(DOT/FAA/CT-TN89/42) Avail: NTIS HC A03/MF A01

Computed centerline approaches can be divided into two subclasses: approaches to an instrument runway with an offset azimuth configuration, and approaches to a runway parallel to the primary instrumented runway. The use of lateral position computation algorithms that do not require an input elevation parameter were proposed for situations where a full three-dimensional algorithm would be difficult in terms of memory requirements or computational power. The impact of siting configurations on the accuracy of this type of algorithm was investigated to determine its acceptability for different categories of operation. The results of this investigation are presented. Author

**N90-23380#** Transportation Systems Center, Cambridge, MA.
**US COAST GUARD RADIONAVIGATION SYSTEM USER SURVEY Final Report, May 1988 - Jan. 1989**
Anand S. Prabhakar Feb. 1990 164 p
(AD-A218480; DOT-TSC-CG-90-1; DOT-CG-N-01-90) Avail: NTIS HC A08/MF A01 CSCL 17/7

The findings of a national mail survey of civilian marine and terrestrial users of federally-operated Radionavigation Systems (RNS) are documented. The main objectives of the survey were to gather empirical data on the use pattern of current RNSs and on user predisposition towards proposed satellite-based systems. Three populations were targeted: owners of boats 26 feet and above length overall, U.S. parent companies owning U.S. or foreign flagged vessels and U.S. terrestrial surveyors and mappers. The survey was conducted in 1988 on behalf of U.S. Coast Guard by the Transportation Systems Center; the overall response rate was 61 percent of the total sample. GRA

**N90-23381#** Naval Postgraduate School, Monterey, CA. Dept. of Oceanography.
**DIFFERENTIAL LORAN-C USING THREE SECONDARY STATIONS M.S. Thesis**
David F. Purdy Sep. 1989 94 p Sponsored by Defense Mapping Agency Hydrographic and Topographic Center, Washington, DC
(AD-A219573) Avail: NTIS HC A05/MF A01 CSCL 17/7

Loran-C time difference (TD) readings were taken consecutively at several survey stations near Monterey, CA, over a period of three days. One station, Range-7, was designated the known point of a differential Loran-C system. Readings from the known point were used to correct readings from a second survey station, Luces Point. A method of improving the precision of Loran-C TD readings based on the redundancy and relative accuracy of three LOP's was developed and applied to the data. Since only one receiver was available, a linear regression of TD vs time was calculated and used in the differential correction. Based on 496 sets of data taken at 5-second intervals at Range-7 in two groups, before and after about 250 readings at Luces Point, the absolute accuracy of Luces Point data was improved from about 385 m to about 48 m compared to the known position of the point. Precision was improved from about 14.9 m to about 12.6 m circular error (CEP) using the three station correction. Further improvement would probably have resulted if two receivers were available for real time corrections. GRA

**N90-23382#** Naval Postgraduate School, Monterey, CA. Dept. of Electronic Warfare.
**EVALUATION OF VHF INTERCEPT AND DIRECTION FINDING SYSTEMS M.S. Thesis**
Muhammad Aleem Siddiqui Sep. 1989 90 p
(AD-A219805) Avail: NTIS HC A05/MF A01 CSCL 17/11

The VHF Intercept and Direction Finding (DF) collection systems developed by ESL International, Watkins Johnson, and HRB Singer for induction into a divisional level signal battalion of the Pakistan Army is evaluated. The introduction of the proposed system is expected to enhance existing intercept and Direction Finding (DF) Capabilities. The three systems are evaluated on the basis of performance, design and supportability characteristics. In the process each system element is further broken into subelements composed of significant intercept and DF systems characteristics. The expected threat environment and the capabilities of modern intercept and DF systems provided practical and workable rationale and criteria for this purpose. The conclusion is that the system developed by ESL International offers significant capabilities of meeting the needs of expected divisional level threat environments. A major recommendation is that the system capabilities be verified by carrying out a dedicated operational testing program before finalizing the acquisition proposal. GRA

**N90-23383#** Army Engineer Topographic Labs., Fort Belvoir, VA.
**THREE APPROXIMATE METHODS FOR ESTIMATING THE BEST SUBSET OF GPS SATELLITES FOR SATELLITE POSITION CALCULATIONS**
Michael A. Crombie Feb. 1990 48 p
(DA Proj. 4A7-62707-A-855)
(AD-A220380; ETL-0556) Avail: NTIS HC A03/MF A01 CSCL 17/7

Three methods approximating the best subset of four or five of N observable GPS satellites to be used for calculating spatial positions are evaluated. Position Dilution of Precision (PDOP) is used as the measure of effectiveness. Three GPS constellations are considered. The user spatial positions are taken from circular orbits ranging from 100 to 2400 nautical miles above the earth and from orbital inclinations ranging from 0 degrees to 90 degrees in 15 degree increments. GRA

**N90-23384#** Defence Research Establishment, Ottawa (Ontario). Communications Electronic Warfare Section.
**MODEL ORDER DETERMINATION METHODS FOR AUTOREGRESSIVE RADIO DIRECTION FINDING TECHNIQUES**
W. Read Jan. 1990 32 p
(AD-A220707; DREO-TN-90-2) Avail: NTIS HC A03/MF A01 CSCL 17/7

This report reviews methods to determine the optimum model order of adaptive filter techniques applied to the problem of tactical radio direction finding (DF), and the related issue of the determination of the number of signals for adaptive filter techniques using eigen decomposition techniques. This work was carried out in support of research into advanced radio direction finding techniques for land tactical applications. For radio direction finding applications, adjusting the adaptive filter model order to a value less than the maximum (i.e., one less than the number of antennas in the sensor array) increases the ability of an adaptive filter based DF algorithm to resolve multipath signals. It is from this point of view that model order determination methods are discussed in this report. In general, the optimum model order is not known beforehand, so a number of model order determination methods have been proposed to tackle this problem. In this report, these are classified according to the autocorrelation matrix estimator used. Three classes of estimators are considered, which are: (1) the autocorrelation method, (2) the covariance and modified covariance method, and (3) the eigen decomposition method. GRA

**N90-23385#** Mitre Corp., Bedford, MA.
**PRELIMINARY EVALUATION OF A SMALL WEARABLE DISPLAY Final Report**
R. J. Blaha and J. M. Kistner Feb. 1990 55 p
(Contract F19628-89-C-0001; AF Proj. 6210)
(AD-A219867; MTR-10705; ESD-TR-89-318) Avail: NTIS HC A04/MF A01 CSCL 17/5

A preliminary evaluation was performed on a small display called the Private Eye, which is worn in front of one eye. Seventeen subjects entered simulated air traffic controller flight strip information from this device. Subjective ratings on its various characteristics ranged from slightly favorable to neutral. When comparing the Private Eye to printed material, the Private Eye was slightly slower and more error prone. This monochrome (red) display was designed to be worn in front of one eye. Using conventional semiconductor and optical techniques, it provides the equivalent amount of information to that of a 12-inch monitor driven by a PC. A highly concentrated, data input task was chosen to obtain hands-on experience with this new display device, and to quickly identify the potential advantages and deficiencies in the device. This task required the keyboard entry of information from the Private Eye into simulated air traffic flight strips, with key entries displayed by a personal computer. Subjective evaluations were the emphasis of the study, and were quantified on a seven-point rating scale. GRA

**N90-23433** Ministry of Defence, Paris (France).
**THE GPS-NAVSTAR LOCATION AND NAVIGATION SYSTEM**
Nicolas deCheyzelles *In* CNES, Location and Navigation Satellite Systems Mar. 1989 p 375-397 In FRENCH; ENGLISH summary (For primary document see N90-23420 17-12)
Copyright Avail: CEPADUES-Editions, 111 rue Nicolas-Vauquelin, 31100 Toulouse, France

**N90-23434** Centre National d'Etudes Spatiales, Toulouse (France).
**SATELLITE NAVIGATION SYSTEM PROJECTS: EUROPEAN COMPLEMENT TO GPS (CE-GPS), NAVSAT**
Jean-Marie Durand *In its* Location and Navigation Satellite Systems Mar. 1989 p 399-426 In FRENCH; ENGLISH summary (For primary document see N90-23420 17-12)
Copyright Avail: CEPADUES-Editions, 111 rue Nicolas-Vauquelin, 31100 Toulouse, France

**N90-23435** Geostar Messaging Corp., Washington, DC.
**THE GEOSTAR LOCATION AND MESSAGING SYSTEM**
Robert D. Briskman *In* CNES, Location and Navigation Satellite Systems Mar. 1989 p 427-435 In ENGLISH; FRENCH summary (For primary document see N90-23420 17-12)
Copyright Avail: CEPADUES-Editions, 111 rue Nicolas-Vauquelin, 31100 Toulouse, France

**N90-23436** Centre National d'Etudes Spatiales, Toulouse (France).
**LOCSTAR: A SATELLITE RADIODETERMINATION SYSTEM FOR EUROPE**
Raymond Rosso *In its* Location and Navigation Satellite Systems Mar. 1989 p 437-453 In FRENCH; ENGLISH summary (For primary document see N90-23420 17-12)
Copyright Avail: CEPADUES-Editions, 111 rue Nicolas-Vauquelin, 31100 Toulouse, France

**N90-23437** Centre National d'Etudes Spatiales, Toulouse (France).
**COMPARISON OF LOCATION SYSTEMS**
Claude Gal *In its* Location and Navigation Satellite Systems Mar. 1989 p 455-466 In FRENCH; ENGLISH summary (For primary document see N90-23420 17-12)
Copyright Avail: CEPADUES-Editions, 111 rue Nicolas-Vauquelin, 31100 Toulouse, France

**N90-23438** Direction Generale de l'Aviation Civile, Paris (France).
**COMPARISON OF NAVIGATION SYSTEMS**
Olivier Carel *In* CNES, Location and Navigation Satellite Systems Mar. 1989 p 467-480 In FRENCH; ENGLISH summary (For primary document see N90-23420 17-12)
Copyright Avail: CEPADUES-Editions, 111 rue Nicolas-Vauquelin, 31100 Toulouse, France

# 05 AIRCRAFT DESIGN, TESTING AND PERFORMANCE

Includes aircraft simulation technology.

For related information see also *18 Spacecraft Design, Testing and Performance* and *39 Structural Mechanics*.For land transportation vehicles see *85 Urban Technology and Transportation.*

**N90-23386*#** Kansas Univ. Center for Research, Inc., Lawrence. Flight Research Lab.
**FIGHTER AGILITY METRICS, RESEARCH, AND TEST**
Randall K. Liefer, John Valasek, and David P. Eggold 19 Jun. 1990 200 p
(Contract NCC2-588)
(NASA-CR-186118; NAS 1.26:186118; KU-FRL-831-2) Avail: NTIS HC A09/MF A02 CSCL 01C

Proposed new metrics to assess fighter aircraft agility are collected and analyzed. A framework for classification of these new agility metrics is developed and applied. A completed set of transient agility metrics is evaluated with a high fidelity, nonlinear F-18 simulation provided by the NASA Dryden Flight Research Center. Test techniques and data reduction methods are proposed. A method of providing cuing information to the pilot during flight test is discussed. The sensitivity of longitudinal and lateral agility metrics to deviations from the pilot cues is studied in detail. The metrics are shown to be largely insensitive to reasonable deviations from the nominal test pilot commands. Instrumentation required to quantify agility via flight test is also considered. With one exception, each of the proposed new metrics may be measured with instrumentation currently available. Simulation documentation and user instructions are provided in an appendix. Author

**N90-23387#** Army Aviation Engineering Flight Activity, Edwards AFB, CA.
**PRELIMINARY AIRWORTHINESS EVALUATION OF THE RC-12K Final Report, 12 Jun. - 22 Jun. 1989**
Joseph C. Miess, George M. Yamakawa, Robert D. Robbins, and Warren P. Gould Aug. 1989 102 p
(AD-A219545; USAAEFA-88-03) Avail: NTIS HC A06/MF A01 CSCL 01/3

During this test program, ten flights were conducted for a total of 22.8 hours, of which 14.6 hours were productive. Tests were performed in the Guardrail/Common Sensor System mission configuration ballasted to an average gross weight of 16,000 lb and centers of gravity at fuselage station 188.1 (forward) and 195.1 (aft). Test results were evaluated against military specification MIL-F-8785C for handling qualities. Performance data presented in the operator's manual were confirmed, as was the Beech Aircraft Corp. provided drag polar. The RC-12K test aircraft had good takeoff, accelerate-stop, landing, and climb performance. At 16,000 lb maximum gross weight, the standard day service ceiling is above the certified ceiling of 35,000 ft. The handling qualities of the RC-12K were satisfactory. Minimum control speeds dictated that the flaps down approach speed was 106 knots indicated airspeed regardless of weight. The heavy-duty main gear wheel and brake system contributed to good accelerate-stop and landing performance. Lack of adequate stall warning and the poor engine cowl securing device were identified as deficiences. One shortcoming was identified. GRA

**N90-23388#** Naval Postgraduate School, Monterey, CA. Dept. of Aeronautics and Astronautics.
**INITIAL FLIGHT TEST OF HALF-SCALE UNMANNED AIR VEHICLE M.S. Thesis**
Yeho Kee Sep. 1989 67 p
(AD-A219584) Avail: NTIS HC A04/MF A01 CSCL 01/3

Pioneer, a short range Unmanned Air Vehicle, was recently introduced into fleet operations. Due to the manner of test and evaluation of UAV's, problems with the air vehicle have been identified during, rather than prior to, operational use and contractor testing. A flight research program has begun at the Naval Postgraduate School to use a half-scale Pioneer UAV in an attempt to study the flight behavior of Pioneer. Limitation of flight endurance below original estimations has prompted a drag analysis of the vehicle to be performed. Previously, wind tunnel work was carried out for propeller studies. The current investigation uses the results of that work to complete flights for determination of a drag polar for the vehicle. A drag clean-up of the original wing configuration was performed, and though the data are scattered due to the measurement techniques trends indicate a significant reduction in drag for the new wing. Comparison of the drag data with numerical predictions shows a reasonable correlation. GRA

**N90-23389#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**DEVELOPMENT OF A LEAST SQUARES TIME RESPONSE LOWER-ORDER EQUIVALENT SYSTEMS TECHNIQUE M.S. Thesis**
Clarke O. Manning Mar. 1990 266 p
(AD-A220527; AFIT/GAE/ENY/90M-02) Avail: NTIS HC A12/MF A02 CSCL 01/1

The most widely accepted method for specifying flying qualities of highly-augmented aircraft is the low-order equivalent systems technique. This technique matches the frequency response of a high-order system (HOS) with a lower-order equivalent system (LOES). The LOES is generally in the form of a classical (unaugmented) aircraft so that comparisons with the classical data base can be made. Most LOES research has been accomplished using frequency response matching. However there are also methods available for matching the time responses of the HOS and LOES. Time response matching is an attractive option for flight test applications since all that is required is output versus input data. This thesis develops and tests a Least Squares LOES time response matching program. The program was tested analytically at the Air Force Institute of Technology,

Wright-Patterson AFB, OH. During the analytical testing, a HOS was modeled using an A-4D aircraft with servo-actuator and feel system dynamics. Lower order equivalent parameters were calculated using the Least Squares program and the results were compared to those obtained using a frequency response matching program (LONFIT). Various flight conditions and feel system dynamics were used to change the HOS dynamics and the effects of these changes on the two matching techniques were investigated. GRA

**N90-23390*** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**ACTUATED FOREBODY STRAKES Patent**
Daniel G. Murri, inventor (to NASA) 17 Apr. 1990 11 p Filed 11 May 1988 Supersedes N88-24628 (26 - 18, p 2464)
(NASA-Case-LAR-13983-1; US-Patent-4,917,333; US-Patent-Appl-SN-192563; US-Patent-Class-244-75R; US-Patent-Class-244-45A; US-Patent-Class-244-46; US-Patent-Class-244-90R; Int-Patent-Class-B64C-9/02; Int-Patent-Class-B64C-9/08) Avail: US Patent and Trademark Office CSCL 01C

Actuated forebody strakes provide yaw control at high angles of attack. In one embodiment, the strakes are axially slidable in the forebody to be deployed out of slots provided for the strakes in the forebody. In another embodiment, the strakes are pivotally connected at the tip of the strakes to pivot radially outwardly out of the slots provided in the forebody. In another embodiment, the forebody is provided with either a single strake or two strakes and the forebody is rotatable to vary the radial location of the strake or strakes. All embodiments achieve significant yaw control capability over a wide angle of attack and sideslip ranges.
Official Gazette of the U.S. Patent and Trademark Office

**N90-23391*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**OVERCOMING THE BELLMAN'S CURSE OF DIMENSIONALITY IN LARGE OPTIMIZATION PROBLEMS**
Jaroslaw Sobieszczanski-Sobieski Apr. 1990 6 p Presented at the 2nd Pan American Congress of Applied Mechanics, Valparaiso, Chile, 2-5 Jan. 1991
(NASA-TM-102662; NAS 1.15:102662) Avail: NTIS HC A02/MF A01 CSCL 01C

Decomposition of large problems into a hierarchic pyramid of subproblems was proposed in the literature as a means for optimization of engineering systems too large for all-in-one optimization. This decomposition was established heuristically. The dynamic programming (DP) method due to Bellman was augmented with an optimum sensitivity analysis that provides a mathematical basis for the above decomposition, and overcomes the curse of dimensionality that limited the original formulation of DP. Numerical examples are cited. Author

**N90-23392*#** National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
**ESTIMATING SHORT-PERIOD DYNAMICS USING AN EXTENDED KALMAN FILTER**
Jeffrey E. Bauer and Dominick Andrisani (Purdue Univ., West Lafayette, IN.) 1990 38 p Presented at the 5th Biannual Flight Test Conference, Ontario, CA, 21-24 May 1990 Previously announced in IAA as A90-33901
(NASA-TM-101722; H-1625; NAS 1.15:101722) Avail: NTIS HC A03/MF A01 CSCL 01C

An extended Kalman filter (EKF) is used to estimate the parameters of a low-order model from aircraft transient response data. The low-order model is a state space model derived from the short-period approximation of the longitudinal aircraft dynamics. The model corresponds to the pitch rate to stick force transfer function currently used in flying qualities analysis. Because of the model chosen, handling qualities information is also obtained. The parameters are estimated from flight data as well as from a six-degree-of-freedom, nonlinear simulation of the aircraft. These two estimates are then compared and the discrepancies noted. The low-order model is able to satisfactorily match both flight data and simulation data from a high-order computer simulation. The parameters obtained from the EKF analysis of flight data are compared to those obtained using frequency response analysis of the flight data. Time delays and damping ratios are compared and are in agreement. This technique demonstrates the potential to determine, in near real time, the extent of differences between computer models and the actual aircraft. Precise knowledge of these differences can help to determine the flying qualities of a test aircraft and lead to more efficient envelope expansion.
Author

**N90-23393*#** General Electric Co., Cincinnati, OH. Advanced Technology Operations.
**EXPERIMENTAL PERFORMANCE AND ACOUSTIC INVESTIGATION OF MODERN, COUNTERROTATING BLADE CONCEPTS Final Report**
G. E. Hoff Jan. 1990 659 p
(Contract NAS3-24080)
(NASA-CR-185158; NAS 1.26:185158) Avail: NTIS HC A99/MF A04 CSCL 01C

The aerodynamic, acoustic, and aeromechanical performance of counterrotating blade concepts were evaluated both theoretically and experimentally. Analytical methods development and design are addressed. Utilizing the analytical methods which evolved during the conduct of this work, aerodynamic and aeroacoustic predictions were developed, which were compared to NASA and GE wind tunnel test results. The detailed mechanical design and fabrication of five different composite shell/titanium spar counterrotating blade set configurations are presented. Design philosophy, analyses methods, and material geometry are addressed, as well as the influence of aerodynamics, aeromechanics, and aeroacoustics on the design procedures. Blade fabrication and quality control procedures are detailed; bench testing procedures and results of blade integrity verification are presented; and instrumentation associated with the bench testing also is identified. Additional hardware to support specialized testing is described, as are operating blade instrumentation and the associated stress limits. The five counterrotating blade concepts were scaled to a tip diameter of 2 feet, so they could be incorporated into MPS (model propulsion simulators). Aerodynamic and aeroacoustic performance testing was conducted in the NASA Lewis 8 x 6 supersonic and 9 x 15 V/STOL (vertical or short takeoff and landing) wind tunnels and in the GE freejet anechoic test chamber (Cell 41) to generate an experimental data base for these counterrotating blade designs. Test facility and MPS vehicle matrices are provided, and test procedures are presented. Effects on performance of rotor-to-rotor spacing, angle-of-attack, pylon proximity, blade number, reduced-diameter aft blades, and mismatched rotor speeds are addressed. Counterrotating blade and specialized aeromechanical hub stability test results are also furnished. Author

**N90-23394*#** Kansas Univ., Lawrence.
**PRELIMINARY DESIGN OF A SUPERSONIC SHORT TAKEOFF AND VERTICAL LANDING (STOVL) FIGHTER AIRCRAFT**
Larry Bellmard, Paul Borchers, Charlie Gomer, Dean Henderson, Tavis Jacobs, Todd Lawson, Eric Peterson, and Tweed Ross, III 1990 422 p
(Contract NASw-4435)
(NASA-CR-186670; NAS 1.26:186670) Avail: NTIS HC A18/MF A03 CSCL 01C

The preliminary design study of a supersonic Short Takeoff and Vertical Landing (STOVL) fighter is presented. A brief historical survey of powered lift vehicles was presented, followed by a technology assessment of the latest supersonic STOVL engine cycles under consideration by industry and government in the U.S. and UK. A survey of operational fighter/attack aircraft and the modern battlefield scenario were completed to develop, respectively, the performance requirements and mission profiles for the study. Three configurations were initially investigated with the following engine cycles: a hybrid fan vectored thrust cycle, a lift+lift/cruise cycle, and a mixed flow vectored thrust cycle. The lift+lift/cruise aircraft configuration was selected for detailed design work which consisted of: (1) a material selection and structural

layout, including engine removal considerations, (2) an aircraft systems layout, (3) a weapons integration model showing the internal weapons bay mechanism, (4) inlet and nozzle integration, (5) an aircraft suckdown prediction, (6) an aircraft stability and control analysis, including a takeoff, hover, and transition control analysis, (7) a performance and mission capability study, and (8) a life cycle cost analysis. A supersonic fighter aircraft with STOVL capability with the lift+lift/cruise engine cycle seems a viable option for the next generation fighter. Author

**N90-23395*#** Auburn Univ., AL.
**AVION: A DETAILED REPORT ON THE PRELIMINARY DESIGN OF A 79-PASSENGER, HIGH-EFFICIENCY, COMMERCIAL TRANSPORT AIRCRAFT**
William Mayfield, Brett Perkins, William Rogan, Randall Schuessler, and Joe Stockert Jun. 1990 87 p
(Contract NASw-4435)
(NASA-CR-186663; NAS 1.26:186663) Avail: NTIS HC A05/MF A01 CSCL 01C

The Avion is the result of an investigation into the preliminary design for a high-efficiency commercial transport aircraft. The Avion is designed to carry 79 passengers and a crew of five through a range of 1,500 nm at 455 kts (M=0.78 at 32,000 ft). It has a gross take-off weight of 77,000 lb and an empty weight of 42,400 lb. Currently there are no American-built aircraft designed to fit the 60 to 90 passenger, short/medium range marketplace. The Avion gathers the premier engineering achievements of flight technology and integrates them into an aircraft which will challenge the current standards of flight efficiency, reliability, and performance. The Avion will increase flight efficiency through reduction of structural weight and the improvement of aerodynamic characteristics and propulsion systems. Its design departs from conventional aircraft design tradition with the incorporation of a three-lifting-surface (or tri-wing) configuration. Further aerodynamic improvements are obtained through modest main wing forward sweeping, variable incidence canards, aerodynamic coupling between the canard and main wing, leading edge extensions, winglets, an aerodynamic tailcone, and a T-tail empennage. The Avion is propelled by propfans, which are one of the most promising developments for raising propulsive efficiencies at high subsonic Mach numbers. Special attention is placed on overall configuration, fuselage layout, performance estimations, component weight estimations, and planform design. Leading U.S. technology promises highly efficient flight for the 21st century; the Avion will fulfill this promise to passenger transport aviation. Author

**N90-23396*#** Auburn Univ., AL. Dept. of Aerospace Engineering.
**HIGH SPEED CIVIL TRANSPORT**
Scott Bogardus, Brent Loper, Chris Nauman, Jeff Page, Rusty Parris, and Greg Steinbach Jun. 1990 94 p
(Contract NASw-4435)
(NASA-CR-186661; NAS 1.26:186661) Avail: NTIS HC A05/MF A01 CSCL 01C

The design process of the High Speed Civil Transport (HSCT) combines existing technology with the expectation of future technology to create a Mach 3.0 transport. The HSCT was designed to have a range in excess of 6000 nautical miles and carry up to 300 passengers. This range will allow the HSCT to service the economically expanding Pacific Basin region. Effort was made in the design to enable the aircraft to use conventional airports with standard 12,000 foot runways. With a takeoff thrust of 250,000 pounds, the four supersonic through-flow engines will accelerate the HSCT to a cruise speed of Mach 3.0. The 679,000 pound (at takeoff) HSCT is designed to cruise at an altitude of 70,000 feet, flying above most atmospheric disturbances. Author

**N90-23397*#** Worcester Polytechnic Inst., MA.
**FEASIBILITY STUDY FOR A MICROWAVE-POWERED OZONE SNIFFER AIRCRAFT B.S. Thesis**
David F. Botros, Charlotte K. Cody, Noah P. Forden, Martin A. Helsing, Thomas H. Jutras, DoHoon Kim, Christopher Labarre, Ethan M. Odin, and Scott B. Sandler 1990 340 p
(Contract NASw-4435; Proj. MSG-89A1)
(NASA-CR-186660; NAS 1.26:186660) Avail: NTIS HC A15/MF A02 CSCL 01C

The preliminary design of a high-altitude, remotely-piloted, atmospheric-sampling aircraft powered by microwave energy beamed from ground-based antenna was completed. The vehicle has a gross weight of 6720 pounds and is sized to carry a 1000 pound payload at an altitude of 100,000 feet. The underside of the wing serves as the surface of a rectenna designed to receive microwave energy at a power density of 700 watts per square meter and the wing has a planform area of 3634 square feet to absorb the required power at an optimum Mach number M = 0.44. The aircraft utilizes a horizontal tail and a canard for longitudinal control and to enhance the structural rigidity of the twin fuselage configuration. The wing structure is designed to withstand a gust-induced load factor n = 3 at cruise altitude but the low-wing loading of the aircraft makes it very sensitive to gusts at low altitudes, which may induce load factors in excess of 20. A structural load alleviation system is therefore proposed to limit actual loads to the designed structural limit. Losses will require transmitted power on the order of megawatts to be radiated to the aircraft from the ground station, presenting environmental problems. Since the transmitting antenna would have a diameter of several hundred feet, it would not be readily transportable, so we propose that a single antenna be constructed at a site from which the aircraft is flown. The aircraft would be towed aloft to an initial altitude at which the microwave power would be utilized. The aircraft would climb to cruise altitude in a spiral flight path and orbit the transmitter in a gentle turn. Author

# 06 AIRCRAFT INSTRUMENTATION

Includes cockpit and cabin display devices; and flight instruments.

For related information see also *19 Spacecraft Instrumentation* and *35 Instrumentation and Photography*.

**N90-23398#** Wright Research Development Center, Wright-Patterson AFB, OH. Environmental Control Branch.
**CORRELATION/VALIDATION OF FINITE ELEMENT CODE ANALYSES FOR VIBRATION ASSESSMENT OF AVIONIC EQUIPMENT Final Report, Mar. 1985 - Sep. 1989**
Amar Bhungalia and George Kurylowich 31 Dec. 1989 35 p
(AF Proj. 2402)
(AD-A220393; WRDC-TR-89-3110) Avail: NTIS HC A03/MF A01 CSCL 12/5

Avionics Environmental Reliability is a major issue for present and future military aircrafts. The printed wiring boards are getting more and more populated with electronic components because of very complex avionics requirements with limited space available in the avionic bay. With this limited available space, we are forced to design the printed wiring board with very densely populated electronic components. It appears that this kind of condition can create structural integrity problems for avionics in military aircrafts. It has been determined that vibration and thermal environments are major problems in military avionics, and these environments cause more than half avionics failures. There is a need to evaluate a design before we approve go ahead on production of these complex avionics boxes. WRDC/FIVE has started to develop a computer capability to predict avionics reliability prior to production, so that the design can be changed if it does not meet the Air Force requirements. WRDC/FIVE has selected/developed a finite element program which will allow avionics reliability prediction. The Numerically Integrated elements for System Analysis (NISA) software was selected to accomplish this task. In May 1984, the Environmental Control Branch (WRDC/FIVE) started In-House effort to validate vibration prediction using NISA and test data acquired from laboratory test, with similar boundary conditions. This report contains the results of validation of predictions by showing comparisons with test data. GRA

**N90-23399*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**HELICOPTER AIRBORNE LASER POSITIONING SYSTEM (HALPS)**
Joseph C. Eppel, Howard Christiansen (Northrop Services, Inc., Sunnyvale, CA.), Jeffrey Cross, and Joseph Totah Mar. 1990 21 p Presented at the Optical Engineering and Aerospace Sensing Meeting, Orlando, FL, 16-20 Apr. 1990
(NASA-TM-102814; A-90139; NAS 1.15:102814) Avail: NTIS HC A03/MF A01 CSCL 01D

The theory of operation, configuration, laboratory, and ground test results obtained with a helicopter airborne laser positioning system developed by Princeton University is presented. Unfortunately, due to time constraints, flight data could not be completed for presentation at this time. The system measures the relative position between two aircraft in three dimensions using two orthogonal fan-shaped laser beams sweeping across an array of four detectors. Specifically, the system calculates the relative range, elevation, and azimuth between an observation aircraft and a test helicopter with a high degree of accuracy. The detector array provides a wide field of view in the presence of solar interference due to compound parabolic concentrators and spectral filtering of the detector pulses. The detected pulses and their associated time delays are processed by the electronics and are sent as position errors to the helicopter pilot who repositions the aircraft as part of the closed loop system. Accuracies obtained in the laboratory at a range of 80 ft in the absence of sunlight were + or - 1 deg in elevation; +0.5 to -1.5 deg in azimuth; +0.5 to -1.0 ft in range; while elevation varied from 0 to +28 deg and the azimuth varied from 0 to + or - 45 deg. Accuracies in sunlight were approximately 40 deg (+ or - 20 deg) in direct sunlight.
Author

**N90-23400#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**CONTINUED DEVELOPMENT AND ANALYSIS OF A NEW EXTENDED KALMAN FILTER FOR THE COMPLETELY INTEGRATED REFERENCE INSTRUMENTATION SYSTEM (CIRIS) M.S. Thesis**
Faron Britt Snodgrass Mar. 1990 174 p
(AD-A220106; AFIT/GE/ENG/90M-5) Avail: NTIS HC A08/MF A01 CSCL 12/5

The Completely Integrated Reference Instrumentation System (CIRIS) is operated by the Central Inertial Guidance Test Facility (CIGTF), at Holloman AFB, New Mexico. CIRIS functions as a reference navigation system used for evaluating the accuracy of other types of navigations systems. As a reference standard, the root-mean-square errors in CIRIS estimates of aircraft trajectory variables must be maintained an order of magnitude smaller that the corresponding errors of the navigation system under test. The primary hardware components of CIRIS are a reference inertial navigation system (INS), a baro-altimeter, an array of ground-based transponders, a transponder interrogator, and data recording equipment. The transponder equipment provides transponder-to-aircraft range and range-rate measurements during test flights. The primary software component of CIRIS is a Kalman filter program which processes the recorded measurements and estimates the true position and velocity of the aircraft throughout the test flight. The estimation accuracy of CIRIS must be increased so that CIRIS can serve as a benchmark for measuring the accuracy of Global Positioning System (GPS) aided inertial navigation systems. The continuation of research to develop completely new Kalman filter software for CIRIS is documented. GRA

# 07 AIRCRAFT PROPULSION AND POWER

Includes prime propulsion systems and systems components, e.g., gas turbine engines and compressors; and onboard auxilliary power plants for aircraft.

For related information see also *20 Spacecraft Propulsion and Power, 28 Propellants and Fuels,* and *44 Energy Production and Conversion.*

**N90-23401*#** Illinois Univ., Urbana-Champaign. Coordinated Science Lab.
**AN EXPERIMENTAL STUDY OF FAULT PROPAGATION IN A JET-ENGINE CONTROLLER M.S. Thesis**
Gwan Seung Choi May 1990 43 p
(Grant NAG1-602)
(NASA-CR-181335; NAS 1.26:181335; UILU-ENG-90-2216; CSG-124) Avail: NTIS HC A03/MF A01 CSCL 21E

An experimental analysis of the impact of transient faults on a microprocessor-based jet engine controller, used in the Boeing 747 and 757 aircrafts is described. A hierarchical simulation environment which allows the injection of transients during run-time and the tracing of their impact is described. Verification of the accuracy of this approach is also provided. A determination of the probability that a transient results in latch, pin or functional errors is made. Given a transient fault, there is approximately an 80 percent chance that there is no impact on the chip. An empirical model to depict the process of error exploration and degeneration in the target system is derived. The model shows that, if no latch errors occur within eight clock cycles, no significant damage is likely to happen. Thus, the overall impact of a transient is well contained. A state transition model is also derived from the measured data, to describe the error propagation characteristics within the chip, and to quantify the impact of transients on the external environment. The model is used to identify and isolate the critical fault propagation paths, the module most sensitive to fault propagation and the module with the highest potential of causing external pin errors. Author

**N90-23402#** Air Force Occupational and Environmental Health Lab., Brooks AFB, TX. Human Systems Div.
**A/F32T-9 LARGE TURBO FAN ENGINE ENCLOSED NOISE SUPPRESSOR SYSTEM (T-9 NSS), EXTERIOR FAR-FIELD AND INTERIOR NOISE, MCCONNELL AFB, KANSAS Final Report**
Ali Y. Ali Feb. 1990 178 p
(AD-A220535; USAFOEHL-90-026E100118BNA) Avail: NTIS HC A09/MF A01 CSCL 21/5

Previous reports on the A/F32T-9 Large Turbo Fan Engine Enclosed Noise Suppressor System (T-9 NSS) addressed environmental noise for acceptance test purposes only. This report presents the first article test results for interior and near-field exterior occupational noise exposure during ground runup tests of the following engines: F100, F101-GE-102, F108-CF-100, J57-59W, J85-5, TF30-P7, TF33-P3 and the TF41-A1. GRA

**N90-23403*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**EXPERIMENTAL EVALUATION OF A TUNED ELECTROMAGNETIC DAMPER FOR VIBRATION CONTROL OF CRYOGENIC TURBOPUMP ROTORS**
Eliseo DiRusso and Gerald V. Brown Washington Jun. 1990 17 p
(NASA-TP-3005; E-5012; NAS 1.60:3005) Avail: NTIS HC A03/MF A01 CSCL 21E

Experiments were performed on a passive tuned electromagnetic damper that could be used for damping rotor vibrations in cryogenic turbopumps for rocket engines. The tests were performed in a rig that used liquid nitrogen to produce cryogenic turbopump temperatures. This damper is most effective at cryogenic temperatures and is not a viable damper at room temperature. The unbalanced amplitude response of the rotor shaft was measured for undamped (baseline) and damped conditions at the critical speeds of the rotor (approx. 5900 to 6400 rpm) and

the data were compared. The tests were performed for a speed range between 900 and 10 000 rpm. The tests revealed that the damper is very effective for damping single-mode narrow bandwidth amplitude response but is less effective in damping broadband response or multimode amplitude response. Author

**N90-23404*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**ANALYSIS OF INTERNAL FLOW IN A VENTRAL NOZZLE FOR STOVL AIRCRAFT**
C. Frederic Smith (Sverdrup Technology, Inc., Brookpark, OH.) and Jack G. McArdle 1990 21 p Presented at the 26th Joint Propulsion Conference, Orlando, FL, 16-18 Jul. 1990; cosponsored by AIAA, SAE, ASME, and ASEE LIMITED REPRODUCIBILITY: More than 20% of this document may be affected by color photographs Original contains color illustrations
(Contract NAS3-25266)
(NASA-TM-103123; E-5451; NAS 1.15:103123; AIAA-90-1899) Avail: NTIS HC A03/MF A01; 3 functional color pages CSCL 21E

Short takeoff and vertical landing (STOVL) aircraft are planned for possible future development. For these aircraft, the same propulsion system will provide power for lift, hover, and horizontal flight. To accomplish this, many designs include a ventral nozzle to provide part of the vertical thrust required. Understanding and predicting the internal aerodynamic flow caused by a single exhaust duct opening are highly desirable in assessing this concept. A numerical simulation of a ventral nozzle is presented and the results are compared with experimental data. Comparisons include visualizations of the flow along the ventral duct walls and in the tailpipe plane of symmetry. Performance calculations are also compared with measured values. Author

**N90-23405*#** Calspan-Buffalo Univ. Research Center, NY.
**HEAT TRANSFER AND PRESSURE MEASUREMENTS FOR THE SSME FUEL-SIDE TURBOPUMP**
Michael G. Dunn Jul. 1990 29 p
(Grant NAG3-581)
(NASA-CR-184928; NAS 1.26:184928) Avail: NTIS HC A03/MF A01 CSCL 21E

A measurement program is currently underway at the Calspan-UB Research Center (CUBRC) which utilizes the Rocketdyne two-state fuel-side turbine with the engine geometric configuration reproduced. This is a full two-state turbine for which the vane rows and the blades are the engine hardware currently used on the Space Shuttle turbopump. A status report is provided for the experimental program and a description of the instrumentation and the measurements to be performed. The specific items that will be illustrated and described are as follows: (1) the gas flow path, (2) the heat-flux instrumentation, (3) the surface-pressure instrumentation, (4) the experimental conditions for which data will be obtained, and (5) the specific measurements that will be performed. Author

**N90-23406*#** Sverdrup Technology, Inc., Brookpark, OH.
**COMPUTATIONAL ANALYSIS OF THE FLOWFIELD OF A TWO-DIMENSIONAL EJECTOR NOZZLE Final Report**
Y. H. Choi and W. Y. Soh Jun. 1990 17 p Presented at the 26th Joint Propulsion Conference, Orlando, FL, 16-18 Jul. 1990; cosponsored by AIAA, SAE, and ASME
(Contract NAS3-25266)
(NASA-CR-185255; E-5548; NAS 1.26:185255; AIAA-90-1901) Avail: NTIS HC A03/MF A01 CSCL 21E

A time-iterative full Navier-Stokes code, PARC, is used to analyze the flowfield of a two-dimensional ejector nozzle system. A parametric study was performed for two controlling parameters, duct to nozzle area ratio and nozzle pressure ratio. Results show that there is an optimum area ratio for the efficient pumping of secondary flow. At high area ratios, a freestream flow passes directly through the mixing duct without giving adequate pumping. At low area ratios, the jet boundary blocks the incoming flow. The nozzle pressure ratio variation shows that the pumping rate increases as the pressure ratio increases, provided there is no interaction between the shroud wall and the shock cell structure. Author

**N90-23407*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**NASA LEWIS ICING RESEARCH TUNNEL USER MANUAL**
Ronald H. Soeder and Charles R. Andracchio Jun. 1990 40 p
(NASA-TM-102319; E-5015; NAS 1.15:102319) Avail: NTIS HC A03/MF A01 CSCL 21E

The Icing Research Tunnel (IRT) at Lewis Research Center is described and information is provided for users who which to conduct experiments in this facility. The capabilities of the tunnel test section, main drive system, speed control, and spray bars are described. Tunnel performance maps of water droplet size as a function of liquid water content are presented for a range of test section velocities from 43.5 to 217.3 kn (50 to 250 mph) for two types of spray nozzles. Tunnel facility support systems, which include heated air systems, steam and service air systems, altitude exhaust system, and model electrical power are described. Facility instrumentation capabilities regarding temperature and pressure measurements and model attitude simulation are discussed. Photographic documentation and flow visualization techniques are also described. Preliminary and pretest meeting formats and schedules are outlined. Tunnel user responsibility, personnel safety, and cost of tunnel operation are also stated. The Icing Research Tunnel is equipped to support testing of low-speed models. The IRT is a closed-return atmospheric-type tunnel with rectangular cross sections. Author

# 08 AIRCRAFT STABILITY AND CONTROL

Includes aircraft handling qualities; piloting; flight controls; and autopilots.

For related information see also *05 Aircraft Design, Testing and Performance.*

**N90-23408** California Univ., Berkeley.
**MODELLING AND CONTROL OF A BALLOON BORNE STABILIZED PLATFORM Ph.D. Thesis**
Alfredo Ong Chingcuanco 1989 195 p
Avail: Univ. Microfilms Order No. DA9006281

A balloon-borne stabilized platform for the detection of anisotropy in the Cosmic Background Radiation (CBR) is being developed. The control and design objective is to develop an accurate altitude-azimuth pointing and stabilizing system to keep the targeted celestial source within the beam size of the antenna and detector system. Since the beam has an angular size of 0.33 to 0.75 degree, the pointing error rms should be better than 0.10 degree both in azimuth and elevation. The experimental setup is described and descriptions of the major hardware used in the experiment are given. A mathematical model of the azimuth pointing system is derived. Using pole placement technique, the model is used as a basis to structure and to design a proportional integral derivative (PID) control with constant desaturation of flywheel angular velocity. Model reference adaptive control (MRAC) with constant desaturation of flywheel angular velocity is also developed. The development of software programs to coordinate the experiment is discussed. Software development includes the implementation of computer based PID control and MRAC both with constant desaturation of flywheel velocity, stiction and calibration compensations for the elevation pointing system, strategies for trajectory generations, gyro recovery during flight, data scheduling and other flight operations. Extensive ground test results verified that the software programs are adequate and functional. The first flight launched from the National Scientific Balloon Facility (NSBF) at Palestine, Texas showed that the hardware functioned properly during the course of the experiment. Tracking results indicate that the azimuth pointing is better than 0.02 degree rms, while elevation pointing is better than 0.04 degree

rms. The flywheel angular velocity was also maintained below the saturation limit to provide continuous azimuth pointing.
Dissert. Abstr.

**N90-23409#** McDonnell Aircraft Co., Saint Louis, MO.
**NONFLAMMABLE HYDRAULIC POWER SYSTEM FOR TACTICAL AIRCRAFT. VOLUME 1: AIRCRAFT SYSTEM DEFINITION, DESIGN AND ANALYSIS Final Report, Mar. 1987 - Jun. 1988**
J. B. Greene, A. O. Harmon, J. R. Jeffrey, S. N. Lohe, N. J. Pierce, J. M. Roach, J. J. Shehan, and J. A. Wieldt May 1989 260 p
(Contract F33615-86-C-2600; AF Proj. 3035)
(AD-A218493; WRDC-TR-89-2026-Vol-1) Avail: NTIS HC A12/MF A01 CSCL 13/7

The purpose of the program was to develop and demonstrate an advanced hydraulic system designed to operate using an Air Force developed, nonflammable fluid, chlorotrifluoroethylene (CTFE), at a maximum operating pressure of 8000 psi. A total quantity of 600 gallons of CTFE base stock was manufactured for this program by Halocarbon Products and blended with a lubricity additive and a corrosion inhibitor by the Air Force Materials Laboratory. A major portion of an advanced aircraft flight control system was duplicated using flightweight, flightworthy hydraulic components developed by twenty four equipment suppliers contracted to support the program. In addition to the high pressure and new fluid, the program integrated several advanced concepts which reduce power consumption and system heat rejection. The most significant of these is variable system pressure which allows the system to remain at a lower power setting (3000 psi), until a demand occurs. The computer controlled variable pressure pumps then respond with only the amount of increased power needed. Energy savings remains a key issue with this new technology as future tactical aircraft are projected to require three times as much hydraulic power at peak periods than conventional aircraft. The increased system pressure serves to reduce component size to accommodate thinner wings and offset the increased weight of CTFE fluid. GRA

**N90-23410#** Texas Univ., Austin. Dept. of Aerospace Engineering and Engineering Mechanics.
**A HOMING MISSILE GUIDANCE LAW BASED ON NEW TARGET MANEUVER MODELS Interim Report**
Jason L. Speyer, Minjea Tahk (Integrated Systems, Inc., Santa Clara, CA.), and Kevin D. Kim 30 Oct. 1989 35 p
(Contract F08635-87-K-0417)
(AD-A220392; AFATL-TP-90-01) Avail: NTIS HC A03/MF A01 CSCL 17/7

By using more realistic a priori knowledge about the target motion, tracking of maneuvering targets for homing missiles is enhanced. Since certain targets are assumed to execute evasive maneuvers orthogonal to their velocity vector, a new stochastic dynamic target model is proposed where this orthogonality is embedded. Along with this new acceleration dynamic model, the orthogonality is also enforced by the addition of a fictitious auxiliary measurement. The target states are estimated by the modified gain extended Kalman filter (MGEKF), and the angular target maneuver rate is constructed on-line. A guidance law that minimizes a quadratic performance index subject to the assumed stochastic engagement dynamics that includes state dependent noise is derived. This guidance law is determined in closed form where the gains are an explicit function of the estimated target maneuver ra[illegible] as well as time to go. The numerical simulation for the two-dimensional angle-only measurement case indicates that the proposed target model with the MGEKF leads to remarkable estimation of the target states. Furthermore, the effect on terminal miss distance using this new guidance scheme is given. GRA

**N90-23411#** Texas Univ., Austin. Dept. of Aerospace Engineering and Engineering Mechanics.
**A PASSIVE HOMING MISSILE GUIDANCE LAW BASED ON NEW TARGET MANEUVER MODELS Interim Report**
Jason L. Speyer, Minjea Tahk, Kevin D. Kim, and Debra Harto 30 Jan. 1990 13 p
(Contract F08635-87-K-0417)
(AD-A220419; AFATL-TP-90-05) Avail: NTIS HC A03/MF A01 CSCL 17/7

A new stochastic dynamic target model is proposed on the assumption that certain targets execute evasive maneuvers orthogonal to their velocity vector. Along with this new acceleration dynamic model, the orthogonality is also enforced by the addition of a fictitious auxilliary measurement. The target states are estimated by the modified gain extended Kalman filter, and the angular target maneuver rate is constructed on-line. A guidance law that minimizes a quadratic performance index subject to the assumed stochastic engagement dynamics that includes state dependent noise is derived. This guidance law is determined in closed form where the gains are an explicit function of the estimated target maneuver rate as well as time to go. The numerical simulation for the two-dimensional angle-only measurement case indicates that the proposed target model leads to significant improvement in the estimation of the target states. Furthermore, the effect on terminal miss distance using this new guidance scheme is given and compared to the Gauss-Markov model. GRA

**N90-23412#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**PREDICTION OF LONGITUDINAL PILOT INDUCED OSCILLATIONS USING THE OPTIMAL CONTROL MODEL M.S. Thesis**
Steven W. Lindsey Dec. 1989 194 p
(AD-A220593; AFIT/GAE/ENY/90M-1) Avail: NTIS HC A09/MF A01 CSCL 01/4

This thesis evaluates the OCM in predicting handling qualities and PIO pilot ratings during the approach and landing task. Using two existing PIO databases, analytical prediction schemes were developed using the OCM. The prediction schemes used were flight path error and crossover frequency. The prediction schemes were applied to 12 different aircraft/flight control system landing configurations. The 12 configurations were flight tested using a USAF/Calspan variable stability NT-33A. The OCM was able to predict pilot handling qualities ratings (PHQR) accurately (within one pilot rating) 80 percent of the time. PIO ratings were accurately predicted 96 percent of the time. Due to a PIO rating problem in the original databases, the PIO prediction schemes were modified using flight test data. Additional flight test configurations should be flown to verify the revised flight path error and crossover frequency prediction schemes. Because of the subjective nature of PHQRs and PIO ratings, the flight test results varied between pilots. The correlation between multiengine pilots was better than with the fighter pilot. The crossover frequency prediction scheme was the most accurate predictor of pilot ratings, while the flight path error prediction scheme was slightly more accurate for PIO ratings. Both predictors agreed with classical control theory, showing correlation between flight path error, crossover frequency, and pilot/PIO ratings. The flight path error and crossover frequency rating prediction methods should be used as a tool in flight control system design. GRA

**N90-23413*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**LATERAL-DIRECTIONAL STABILITY AND CONTROL CHARACTERISTICS OF THE QUIET SHORT-HAUL RESEARCH AIRCRAFT (QSRA)**
Jack D. Stephenson, James A. Jeske, and Gordon H. Hardy May 1990 36 p
(NASA-TM-102250; A-90007; NAS 1.15:102250) Avail: NTIS HC A03/MF A01 CSCL 01C

The results are presented of flight experiments to determine the lateral-directional stability and control characteristics of the Quiet Short-Haul Research Aircraft (QSRA), an experimental aircraft designed to furnish information on various aerodynamic characteristics of a transport type of airplane that makes use of the upper-surface blown (USB) flap technology to achieve short takeoff and landing (STOL) performance. The flight program designed to acquire the data consisted of maneuvers produced

by rudder and control-wheel inputs with the airplane in several configurations that had been proposed for landing approach and takeoff operation. The normal stability augmentation system was not engaged during these maneuvers. Time-history records from the maneuvers were analyzed with a parameter estimation procedure to extract lateral-directional stability and control derivatives. For one aircraft configuration in which the USB flaps were deflected 50 deg, several maneuvers were performed to determine the effects of varying the average angle of attack, varying the thrust coefficient, and setting the airplane's upper surface spoilers at a 13 deg symmetrical bias angle . The effects on the lateral characteristics of deflecting the spoilers were rather small and generally favorable. The data indicate that for one test, conducted at low thrust (a thrust coefficient of 0.38), compared with results from tests at thrust coefficients of 0.77 and larger, there was a significant decrease in the lateral control effectiveness, in the yaw damping and in the directional derivative. The directional derivative was also decreased (by about 30 percent) when the average angle of attack of the test was increased from 3 to 16 deg. Author

# 09 RESEARCH AND SUPPORT FACILITIES (AIR)

Includes airports, hangars and runways; aircraft repair and overhaul facilities; wind tunnels; shock tubes; and aircraft engine test stands.

For related information see also *14 Ground Support Systems and Facilities (Space).*

**N90-23414#** National Aerospace Lab., Amsterdam (Netherlands).
**USER'S GUIDE TO THE 1.6 X 2.0 SQUARE m HIGH SPEED WIND TUNNEL HST, PART 1**
1990 63 p Revised
(ETN-90-96772) Avail: NTIS HC A04/MF A01

A combined initial contact with the user and reference book is presented. A systems description and enumeration of operating characteristics, types of testing, model support systems and instrumentation are given. Some special facilities are mentioned together with appropriate instrumentation. Estimation of testing program duration is described. ESA

**N90-23415*** National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
**HIGH TEMPERATURE ELECTRIC ARC FURNACE AND METHOD Patent**
Richard M. Poorman, inventor (to NASA) and Deborah D. Schmidt, inventor (to NASA) 20 Feb. 1990 6 p Filed 13 Jun. 1988 Supersedes N88-28938 (26 - 23, p 3181)
(NASA-Case-MFS-28281-1; US-Patent-4,902,354; US-Patent-Appl-SN-205898; US-Patent-Class-148-4; US-Patent-Class-148-149; US-Patent-Class-148-902; US-Patent-Class-148-903; Int-Patent-Class-C21D-1/09) Avail: US Patent and Trademark Office CSCL 14B

An apparatus and process for improving the microstructure of electrically conducting materials is disclosed by the present invention. A revolving heat source applies heat to the surface of the material evenly and quickly. One or more heat sinks quickly cool the material. In the preferred embodiment, the cooling may be done in such a way as to promote as high a degree of directional grain growth as desired or completely nondirectional grain growth. Official Gazette of the U.S. Patent and Trademark Office

**N90-23416*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**A TEST MATRIX SEQUENCER FOR RESEARCH TEST FACILITY AUTOMATION**
Timothy P. McCartney and Edward F. Emery Jul. 1990 9 p Presented at the 26th Joint Propulsion Conference, Orlando, FL, 16-18 Jul. 1990; cosponsored by AIAA, SAE, ASME, and ASEE
(NASA-TM-103108; E-5432; NAS 1.15:103108; AIAA-90-2386) Avail: NTIS HC A02/MF A01 CSCL 14B

The hardware and software configuration of a Test Matrix Sequencer, a general purpose test matrix profiler that was developed for research test facility automation at the NASA Lewis Research Center, is described. The system provides set points to controllers and contact closures to data systems during the course of a test. The Test Matrix Sequencer consists of a microprocessor controlled system which is operated from a personal computer. The software program, which is the main element of the overall system is interactive and menu driven with pop-up windows and help screens. Analog and digital input/output channels can be controlled from a personal computer using the software program. The Test Matrix Sequencer provides more efficient use of aeronautics test facilities by automating repetitive tasks that were once done manually. Author

# 12 ASTRONAUTICS (GENERAL)

For extraterrestrial exploration see *91 Lunar and Planetary Exploration.*

**N90-23417*#** Naval Academy, Annapolis, MD. Div. of Engineering and Weapons.
**PROJECT LONGSHOT: A MISSION TO ALPHA CENTAURI Final Report**
Curtis West, Sally Chamberlain, Neftali Pagan, and Robert Stevens 1989 90 p Prepared for Universities Space Research Association, Houston, TX
(Contract NASw-4435)
(NASA-CR-186052; NAS 1.26:186052) Avail: NTIS HC A05/MF A01 CSCL 22A

Project Longshot, an exercise in the Advanced Design Program for Space, had as its destination Alpha Centauri, the closest star system to our own solar system. Alpha Centauri, a trinary star system, is 4.34 light years from earth. Although Project Longshot is impossible based on existing technologies, areas that require further investigation in order to make this feat possible are identified. Three areas where advances in technology are needed are propulsion, data processing for autonomous command and control functions, and reliability. Propulsion, possibly by antimatter annihilation; navigation and navigation aids; reliable hardware and instruments; artificial intelligence to eliminate the need for command telemetry; laser communication; and a reliable, compact, and lightweight power system that converts energy efficiently and reliably present major challenges. Project Longshot promises exciting advances in science and technology and new information concerning the universe. J.P.S.

**N90-23418*#** National Academy of Sciences - National Research Council, Washington, DC.
**HUMAN EXPLORATION OF SPACE: A REVIEW OF NASA'S 90-DAY STUDY AND ALTERNATIVES**
H. Guyford Stever, Robert H. Cannon, Jr., Joseph G. Gavin, Jack L. Kerrebrock, Louis J. Lanzerotti, Elliott C. Levinthal, James W. Mar, John H. McElroy, Duane T. McRuer, and William J. Merrell, Jr. (Texas A&M Univ., Galveston.) et al 1990 41 p
(Contract NASw-4003)
(NASA-CR-186394; NAS 1.26:186394) Avail: NTIS HC A03/MF A01 CSCL 22A

The National Research Council (NRC) examines the NASA Report of the 90-Day Study on Human Exploration of the Moon and Mars, and alternative concepts. Included in this paper, prepared for the National Space Council, are the answers to a challenging set of questions posed by the Vice President. Concerns addressed include: the appropriate pace, the scope of human exploration, the level of long-term support required, the technology development available and needed, the feasibility of long-duration human spaceflight in a low-gravity environment, scientific objectives, and other considerations such as costs and risks. J.P.S.

**N90-23419*#** National Academy of Sciences - National Research Council, Washington, DC.
**INTERNATIONAL COOPERATION FOR MARS EXPLORATION AND SAMPLE RETURN**
Eugene H. Levy, William V. Boynton, A. G. W. Cameron, Michael H. Carr, Jennifer H. Kitchell, Peter Mazur, Norman R. Pace, Ronald G. Prinn, Sean C. Solomon, and Gerald J. Wasserburg (California Inst. of Tech., Pasadena.) 1990 53 p
(Contract NASw-4102)
(NASA-CR-186511; NAS 1.26:186511) Avail: NTIS HC A04/MF A01 CSCL 22A

The National Research Council's Space Studies Board has previously recommended that the next major phase of Mars exploration for the United States involve detailed in situ investigations of the surface of Mars and the return to earth for laboratory analysis of selected Martian surface samples. More recently, the European space science community has expressed general interest in the concept of cooperative Mars exploration and sample return. The USSR has now announced plans for a program of Mars exploration incorporating international cooperation. If the opportunity becomes available to participate in Mars exploration, interest is likely to emerge on the part of a number of other countries, such as Japan and Canada. The Space Studies Board's Committee on Cooperative Mars Exploration and Sample Return was asked by the National Aeronautics and Space Administration (NASA) to examine and report on the question of how Mars sample return missions might best be structured for effective implementation by NASA along with international partners. The committee examined alternatives ranging from scientific missions in which the United States would take a substantial lead, with international participation playing only an ancillary role, to missions in which international cooperation would be a basic part of the approach, with the international partners taking on comparably large mission responsibilities. On the basis of scientific strategies developed earlier by the Space Studies Board, the committee considered the scientific and technical basis of such collaboration and the most mutually beneficial arrangements for constructing successful cooperative missions, particularly with the USSR. Author

**N90-23420** Centre National d'Etudes Spatiales, Toulouse (France).
**LOCATION AND NAVIGATION SATELLITE SYSTEMS**
Mar. 1989 503 p In ENGLISH and FRENCH Proceedings of CNES International Space Technology Course, Toulouse, France, 6-10 Mar. 1989
(ISBN-2-85-428-242-6; ISSN-0766-1002; ETN-90-96604)
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The user requirements for location and navigation systems are discussed. Developments in instrumentation, orbital measuring techniques and signal treatment are described. The NAVSTAR, NAVSAT, GEOSTAR, LOCSTAR, ARGOS, SARSAT, and DORIS satellite location systems are outlined. The integration of satellite communications, navigation and monitoring functions is discussed. Financial and institutional aspects of navigation programs are outlined. The use of Kalman filters in treating measurement data is discussed. A comparison of radionavigation systems is presented. For individual titles, see N90-23421 through N90-23441.

**N90-23421** Institut Francais de Navigation, Paris.
**GENERAL INTRODUCTION TO LOCATION AND NAVIGATION CAPABILITIES** **c17**
Jean Prunieras *In* CNES, Location and Navigation Satellite Systems Mar. 1989 p 17-50 In FRENCH; ENGLISH summary (For primary document see N90-23420 17-12)
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An overview of location and navigation services, maritime, aeronautical, and terrestrial, is presented. The need to harmonize the definitions and concepts by which to objectively assess users' requirements and the capability of systems to meet them is stressed. The definitions in use are reviewed. Means of evaluating users' requirements are presented. The use of cost benefit analysis to help in decision making is outlined. The ways in which cost benefit analysis can be applied to the evaluation of present and future location and navigation systems are outlined. ESA

**N90-23422** Airport Operators Council, Washington, DC.
**NAVIGATION REQUIREMENTS: WHAT THEY ARE AND WHERE THEY COME FROM**
Siegbert B. Poritsky *In* CNES, Location and Navigation Satellite Systems Mar. 1989 p 51-65 In ENGLISH; FRENCH summary (For primary document see N90-23420 17-12)
Copyright Avail: CEPADUES-Editions, 111 rue Nicolas-Vauquelin, 31100 Toulouse, France

The requirements of various users for navigation services are discussed. The needs of terrestrial, surface, and marine navigation services are outlined. The similarity of navigation requirements between all three of these user groups is identified. The differences and the frequently elaborate requirements statements are shown not to reflect requirements so much as the process of compromise between real needs and what is considered achievable in practice by requirements writers. The real needs underlying the requirements are identified. ESA

**N90-23423** Ecole Nationale de l'Aviation Civile, Toulouse (France).
**GENERAL PRINCIPLES OF RADIONAVIGATION: SPACE MAPPING** **c17**
Jean-Louis Jonquieres *In* CNES, Location and Navigation Satellite Systems Mar. 1989 p 69-88 In FRENCH; ENGLISH summary (For primary document see N90-23420 17-12)
Copyright Avail: CEPADUES-Editions, 111 rue Nicolas-Vauquelin, 31100 Toulouse, France

Aeronautical radionavigation and satellite-based radiolocation are discussed. The basic technologies underlying existing systems are outlined. To derive the position and velocity of a moving object, radio links must be established between that object and a terrestrial infrastructure or satellite. Ranges, range differences, velocities and angles can then be measured. The techniques of space mapping, in which specific radio parameters are assigned to geometric quantities, is described. Propagation times derived from the signal phase, pulse duration or pseudo-random code are calculated. The use of Doppler frequency shift and of field amplitude using the directional radiation pattern are described. ESA

**N90-23424** Centre National d'Etudes Spatiales, Toulouse (France).
**LOCATION AND NAVIGATION TECHNOLOGY: PUTTING THEORY INTO PRACTICE** **c17**
Bruno Cugny *In its* Location and Navigation Satellite Systems Mar. 1989 p 89-108 In FRENCH; ENGLISH summary (For primary document see N90-23420 17-12)
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Different configurations used in satellite-based radionavigation and radiolocation systems are outlined. One way and two way links are described. The main types of data used in these systems: angle, Doppler, and ranging are described. Particular attention is paid to the properties of Doppler shift measurements used by orbiting satellite systems. The ranging data obtained by spread-spectrum techniques, using pseudo-random codes, is discussed. Results obtained using the latter technique are compared to those obtained using Doppler shift measurements. ESA

**N90-23425** Centre National d'Etudes Spatiales, Toulouse (France).
**RADIO LINKS: INSTRUMENT TECHNOLOGIES** **c32**
Bruno Cugny *In its* Location and Navigation Satellite Systems Mar. 1989 p 109-131 In FRENCH; ENGLISH summary (For primary document see N90-23420 17-12)
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The general architecture of a radiolocation, radionavigation

transmission chain is described. The link budget calculation, illustrating the low power requirements, is shown. Techniques used to derive the useful signal from the noise and to make measurements are outlined. Phase-locked loops, delay-locked loops, and matched filtering are defined. Simple guidelines for sizing the phase-locked loops are given. The importance of the oscillator in such measurements is discussed. Typical Doppler and ranging receiver architectures are described. The prospects for miniaturizing these types of instruments are discussed. ESA

**N90-23426** Centre National d'Etudes Spatiales, Toulouse (France).
**MEASUREMENT ERRORS** **c17**
Jean Saint-Etienne *In its* Location and Navigation Satellite Systems Mar. 1989 p 133-195 In FRENCH; ENGLISH summary (For primary document see N90-23420 17-12)
Copyright Avail: CEPADUES-Editions, 111 rue Nicolas-Vauquelin, 31100 Toulouse, France

A general method for identifying error sources in systems providing location and navigation for and by satellites is presented. Propagation media, tropospheric and ionospheric effects are examined. Methods for computation and correction are given. Equipment induced errors due to antennas, receivers, and signal processing devices are reviewed. General methods of error reduction are outlined. Errors which occur when electrical quantities are converted to geometrical and kinematic data are discussed. ESA

**N90-23427** Centre National d'Etudes Spatiales, Toulouse (France).
**REFERENCE FRAMES: ORBITOGRAPHY** **c13**
Pierre Sengenes *In its* Location and Navigation Satellite Systems Mar. 1989 p 197-286 In FRENCH; ENGLISH summary (For primary document see N90-23420 17-12)
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Modeling of satellite interaction with its environment is discussed. The use of such modeling in orbit determination or orbit restitution is described. The importance of knowing the position and velocity of a satellite at the time a signal is transmitted is identified as crucial for the correct interpretation of that signal. The need for accurate modeling of the forces acting on a satellite in order to determine its trajectory is stressed. The calculations involved in such modeling are presented. Solar radiation pressure and other space environment effects are included in the modeling. ESA

**N90-23428** Centre d'Etudes et de Recherches, Toulouse (France).
**SIGNAL PROCESSING: KALMAN FILTERING** **c32**
Bernard Gimonet *In* CNES, Location and Navigation Satellite Systems Mar. 1989 p 287-300 In FRENCH; ENGLISH summary (For primary document see N90-23420 17-12)
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The problems of mathematical expression and the formulas used in Kalman filtering are described. Two types of applications are outlined: filtering of composite data (position and velocity) and an orbit restitution problem. The use of Kalman filtering in analyzing information from location and navigation systems is described. The need for careful screening of useful information and error models is stressed. Poor choice of such models is shown to lead to defects in filtering quality. ESA

**N90-23429** European Space Agency, Paris (France).
**BACK TO THE STARS** **c17**
Calin Rosetti *In* CNES, Location and Navigation Satellite Systems Mar. 1989 p 301-306 In ENGLISH; FRENCH summary (For primary document see N90-23420 17-12)
Copyright Avail: CEPADUES-Editions, 111 rue Nicolas-Vauquelin, 31100 Toulouse, France

The use of man-made stars, or satellites, in navigation systems is discussed. Cost estimates for terrestrial radionavigation systems and for a global independent civil navigation satellite are compared. A transition from terrestrial systems to total dependence on satellite navigation systems is discussed. Potential savings to users are outlined. The features that a global independent civil navigation satellite system would need to have are identified. These include global coverage, very high integrity and guaranteed global access. Introduction of a civil overlay to eliminate the weaknesses of the military systems presently under deployment is discussed. ESA

**N90-23430** Centre National d'Etudes Spatiales, Toulouse (France).
**LOCATION SYSTEMS: ARGOS, SARSAT** **c13**
Gilbert Portas *In its* Location and Navigation Satellite Systems Mar. 1989 p 307-351 In FRENCH; ENGLISH summary (For primary document see N90-23420 17-12)
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The ARGOS location system is described. The SARSAT search and rescue system, in which France, the U.S., and Canada are partners, is described. The choices made during the development phase of the systems are presented. The effects of these choices on the final design are described. Although the ARGOS and SARSAT systems have very different objectives, they both use Doppler location and data collection by random access and therefore have many technical features in common. The similarities and differences between the two systems are discussed. ESA

**N90-23431** Centre National d'Etudes Spatiales, Toulouse (France).
**THE DORIS SYSTEM** **c13**
Michel Dorrer *In its* Location and Navigation Satellite Systems Mar. 1989 p 353-361 In FRENCH; ENGLISH summary (For primary document see N90-23420 17-12)
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The DORIS system for accurate determination of altimetric satellite orbits is described. It can provide altitude determination to within 10 cm at any time. The system can also be used to located fixed ground beacons, in either an absolute or a relative reference frame, to within 1 cm for geodesic, scientific or monitoring applications. The DORIS system comprises a network of some 50 orbitographic beacons, a dozen location beacons, and receivers onboard SPOT-2, SPOT-3 and TOPEX-POSEIDON (to be launched in 1992). A number of control, processing and data distribution centers complete the system. Locations of these beacons are presented and the operation of the DORIS system is outlined. ESA

**N90-23432** Centre National d'Etudes Spatiales, Toulouse (France).
**SATELLITE ORBITOGRAPHY** **c13**
Francois Nouel *In its* Location and Navigation Satellite Systems Mar. 1989 p 363-372 In FRENCH; ENGLISH summary (For primary document see N90-23420 17-12)
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The most suitable methods or orbit determination are discussed. The constraints related to each method are considered. The DORIS system, the GPS (global positioning system) constellation concept, and the use of geostationary relays in the tracking and data relay satellite system are discussed. Extensions of these existing systems are considered. Several future concepts still in the design stage are discussed. These concepts, based on techniques of stellar refraction, pixel identification, new satellite constellations and the use of optical links instead of radiowaves are given careful consideration. ESA

**N90-23433** Ministry of Defence, Paris (France).
**THE GPS-NAVSTAR LOCATION AND NAVIGATION SYSTEM** **c04**
Nicolas deCheyzelles *In* CNES, Location and Navigation Satellite Systems Mar. 1989 p 375-397 In FRENCH; ENGLISH

summary (For primary document see N90-23420 17-12)
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The specifications and basic characteristics of the GPS (global positioning system) NAVSTAR system are presented. The positioning accuracy, robustness and reliability of the system are discussed. Extensions of the service to civil navigation and geodesy are described. A synchronization service is outlined. Challenges involved in organizing and running the program are identified. Internal regulation problems and global integration of systems are discussed. ESA

**N90-23434** Centre National d'Etudes Spatiales, Toulouse (France).
**SATELLITE NAVIGATION SYSTEM PROJECTS: EUROPEAN COMPLEMENT TO GPS (CE-GPS), NAVSAT** **c04**
Jean-Marie Durand *In its* Location and Navigation Satellite Systems Mar. 1989 p 399-426 In FRENCH; ENGLISH summary (For primary document see N90-23420 17-12)
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Two separate European satellite-aided navigation systems are described. The European complement to GPS (global positioning system), called CE-GPS is an overlay to the GPS system. It is an initially limited, but pragmatic step which aims to overcome the operational constraints of availability and integrity and the political uncertainties of total reliance on the GPS and the Global Navigation System (GLONASS). NAVSAT is designed to offer a dedicated civilian, multi-purpose multi-user service. The international context which has led to the formulation of the two projects and the reasons behind the main decisions on the mission and design parameters are discussed. ESA

**N90-23435** Geostar Messaging Corp., Washington, DC.
**THE GEOSTAR LOCATION AND MESSAGING SYSTEM** **c04**
Robert D. Briskman *In* CNES, Location and Navigation Satellite Systems Mar. 1989 p 427-435 In ENGLISH; FRENCH summary (For primary document see N90-23420 17-12)
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GEOSTAR's implementation of a location and messaging system employing geosynchronous satellites is described. Technical data on services to mobile users and on performance are given. The major elements of the system are detailed. Diagrams of the uplinking and downlinking networks are presented. A photograph of the miniaturized GEOSTAR mobile platform antenna is shown. The overall performance characteristics of the different GEOSTAR systems are presented. The performance of the service is concluded to have exceeded the planned objectives. The system is predicted to grow in capability and capacity and eventually achieve global coverage via integration with systems in other geographic regions. ESA

**N90-23436** Centre National d'Etudes Spatiales, Toulouse (France).
**LOCSTAR: A SATELLITE RADIODETERMINATION SYSTEM FOR EUROPE** **c04**
Raymond Rosso *In its* Location and Navigation Satellite Systems Mar. 1989 p 437-453 In FRENCH; ENGLISH summary (For primary document see N90-23420 17-12)
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The LOCSTAR radiodetermination satellite service is described. It is designed to provide accurate location information to mobile users and their home bases, and a two-way exchange of short messages between these segments. The results of market surveys in Europe are presented. They show a potential market of 400,000 to 800,000 mobile users after six years of operation. These users are essentially in the field of road transport. The LOCSTAR system is based on the same concept as the GEOSTAR system developed in the U.S. LOCSTAR is expected to be operational in 1992, and should cover western Europe and the Mediterranean basin. ESA

**N90-23437** Centre National d'Etudes Spatiales, Toulouse (France).
**COMPARISON OF LOCATION SYSTEMS** **c04**
Claude Gal *In its* Location and Navigation Satellite Systems Mar. 1989 p 455-466 In FRENCH; ENGLISH summary (For primary document see N90-23420 17-12)
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User requirements and new technologies that have developed since the ARGOS system began operating in 1978 are discussed. The development of a number of satellite based location systems is given particular attention. A multi-criterian approach is used to compare the different location systems that are either operational or at experimental or project stages. Interfacing between ARGOS-MOS (a Japanese meteorological satellite). COSPAS-SARSAT and GEOSTAR-LOCSTAR is discussed. ESA

**N90-23438** Direction Generale de l'Aviation Civile, Paris (France).
**COMPARISON OF NAVIGATION SYSTEMS** **c04**
Olivier Carel *In* CNES, Location and Navigation Satellite Systems Mar. 1989 p 467-480 In FRENCH; ENGLISH summary (For primary document see N90-23420 17-12)
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Position determination by radionavigation is discussed. Real or delayed time, number of information sources, and calculation of velocity and altitude parameters are taken into consideration. The number of systems implemented on the same mobile is discussed. The parameters conventionally used to describe navigation systems are reviewed. The OMEGA, LORAN-C, VOR/DME, ILS/MLS, TRANSIT, GPS and GLONASS systems are described. Maritime, aeronautical and other civilian requirements concerning terrestrial navigation systems are outlined. The ability of the systems to match these requirements is discussed. ESA

**N90-23439** International Maritime Satellite Organization, London (England).
**PROSPECTS FOR INTEGRATION OF SATELLITE COMMUNICATIONS, NAVIGATION AND MONITORING FUNCTIONS** **c17**
George Kinal *In* CNES, Location and Navigation Satellite Systems Mar. 1989 p 483-496 In ENGLISH; FRENCH summary (For primary document see N90-23420 17-12)
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The basic equations of analog ranging are shown to be essentially identical to those for digital time synchronization. Digital system design parameters such as energy per bit, bandwidth and data rate indicate that communications and ranging/timing are two sides of the same coin. Integrated user equipment such as navigation receivers and standard C terminals are shown to be less expensive and more convenient to operate than separate systems. Extensive sharing of hardware functions is possible. The distinction between communications and ranging can be considered to be a software matter. The role of Inmarsat in furthering such integration is described. ESA

**N90-23440** Centre National d'Etudes Spatiales, Toulouse (France).
**IMPLEMENTATION OF LOCATION PROGRAMMES** **c81**
Clotaire Pancrate *In its* Location and Navigation Satellite Systems Mar. 1989 p 497-506 In FRENCH; ENGLISH summary (For primary document see N90-23420 17-12)
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Two examples of the implementation of location programs are presented. Implementation of the LOCSTAR system, providing radiodetermination and radiocommunication capabilities for terrestrial vehicles is described. This system is to be operated on a commercial basis. Implementation of the SARSAT-COSPAS satellite-aided search and rescue program is described. This system

is to be operated as a public service. Preliminary studies, cost estimates, and the research necessary for setting up this type of program are described. ESA

**N90-23441** Civil Aviation Authority, London (England).
**NAVIGATION PROGRAMMES: FINANCIAL AND INSTITUTIONAL ASPECTS** **c84**
Maurice A. Gamester *In* CNES, Location and Navigation Satellite Systems Mar. 1989 p 507-520 In ENGLISH; FRENCH summary (For primary document see N90-23420 17-12)
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The role of the International Civil Aviation Organization (ICAO) in promoting satellite aeronautical CNS (communications, navigation and surveillance) is outlined. The need for commitments to be made on satellite CNS services is stressed. The transition to CNS systems, in particular the improved area coverage, raises many institutional issues. The position of ICAO regarding GPS (global positioning system) and GLONASS (global navigation satellite system) is described. The need for system overlays and concerted action in developing systems specifications is stressed. ESA

**N90-23442#** Italspazio, Rome (Italy).
**ARCHIMEDES MISSION ASPECTS**
P. Palmucci and B. Pavesi 1990 6 p
(ETN-90-96556) Avail: NTIS HC A02/MF A01

The main aspects of possible technical solutions in terms of mission characteristics, showing the critical drawbacks in utilizing high elliptical orbits for the satellite system configuration developed under ESA contracts, are presented. The results show that despite the singularity of these orbits, their use allows some advantages mainly related to avoid shadowing effects and to increase the gain of the mobile antenna, sensibly improving the link conditions. Apart from voice communications services, other potential applications of such a system are envisaged, in an attempt to improve the attractiveness of the Archimedes project. ESA

**N90-23443#** Aerospatiale, Cannes (France).
**KNOWLEDGE BASED SYSTEM FOR HERMES ORBITAL OPERATIONS GROUND SUPPORT**
P. Sengenes, J. Amalric, F. Paoli, D. DeGabai, and S. Pouget Jul. 1989 13 p Previously announced in IAA as A90-13396
(Rept-892-440-102; CA-7/89; ETN-90-96659) Copyright Avail: NTIS HC A03/MF A01

Application of a knowledge based system devoted to ground control center support during the Hermes in orbit phase is addressed. Main functions of such a system are fault diagnosis and mission planning. The first development step of the study, aiming to design a mission planning mock-up is presented. Object oriented formalism, goal oriented programming and algorithmic modules driven by heuristics are the main features of this mock-up modeling and architecture. ESA

# 13 ASTRODYNAMICS

Includes powered and free-flight trajectories; and orbital and launching dynamics.

**N90-23444#** Naval Surface Warfare Center, Dahlgren, VA. Dept. of Strategic Systems.
**SEMIANALYTIC SATELLITE THEORY**
Claus Oesterwinter Jul. 1989 77 p
(AD-A220744; NSWC-TR-89-109) Avail: NTIS HC A05/MF A01 CSCL 22/1

The equations of motion for artificial Earth satellites are solved by semianalytic techniques. The force model includes an arbitrary gravity field for the Earth as well as Moon and Sun. All tesseral harmonics are examined for the presence of resonance. Any resonant term is classified according to its period and amplitude. Those exhibiting deep resonance (long-periodic) are integrated numerically. Shallow resonance terms (intermediate period) are evaluated analytically. Additional tests decide whether short-periodic terms are discarded or calculated analytically. Primary variables of the theory are the non-singular Poincare elements. GRA

**N90-23445#** Italspazio, Rome (Italy).
**ORBIT CONTROL STRATEGY FOR A CONSTELLATION OF THREE SATELLITES IN TUNDRA ORBITS**
G. Rondinelli, A. Cramarossa, and F. Graziani (La Sapienza Univ., Rome, Italy ) San Diego, CA AAS Publications Office 1989 14 p Presented at the AAS/AIAA Astrodynamics Specialist Conference, Stowe, VT, 7-10 Aug. 1989
(AAS-89-411; ETN-90-96555) Avail: NTIS HC A03/MF A01

A low-cost orbit control strategy addressed only to control the orbit subtrack (latitude and longitude of the operational loop of the orbit) and to control the apogee passage time-shift, which impacts on the synchronization between the satellites, is studied. This control strategy, exclusively based on in plane maneuvers, consist of adjusting the apogee radius by perigee burns obtaining a semiaxis variation which cancels the total subtrack shift or puts the subtrack on the other side with respect to the nominal position. ESA

**N90-23446#** Norwegian Defence Research Establishment, Kjeller. Forsvarets Forskningsinst.
**ORBIT RECOVERY OF A LOW EARTH ORBITER FROM GPS AND GROUND TRACKING STATIONS**
Kaare Aksnes, Dag Hoegvard, and Svein Hauge 22 Sep. 1989 29 p
(FFI-89/7012; ISSN-0802-2437; ETN-90-96571) Avail: NTIS HC A03/MF A01

The use of the PRARE and GPS (Global Positioning System) microwave tracking system is compared for orbit determination of a Low Earth Orbiter (LEO). Because the upward looking GPS system allows much longer contacts times than does the downward looking PRARE system, GPS appears to be superior for this particular application. It is recommended to determine the GPS orbits dynamically with 5 to 10 GPS reference receivers on the ground, and then to determine the LEO orbit geometrically from onboard GPS measurments to minimum 4 GPS satellites. In the present simulation, the orbits of 18 GPS satellites are computed by means of an analytical theory. On the basis of phase-smoothed pseudorange GPS measurement, LEO's orbit is found to be maintained to 4 m or better under realistic conditions. ESA

**N90-23427** Centre National d'Etudes Spatiales, Toulouse (France).
**REFERENCE FRAMES: ORBITOGRAPHY**
Pierre Sengenes *In its* Location and Navigation Satellite Systems Mar. 1989 p 197-286 In FRENCH; ENGLISH summary (For primary document see N90-23420 17-12)
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**N90-23430** Centre National d'Etudes Spatiales, Toulouse (France).
**LOCATION SYSTEMS: ARGOS, SARSAT**
Gilbert Portas *In its* Location and Navigation Satellite Systems Mar. 1989 p 307-351 In FRENCH; ENGLISH summary (For primary document see N90-23420 17-12)
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**N90-23431** Centre National d'Etudes Spatiales, Toulouse (France).
**THE DORIS SYSTEM**
Michel Dorrer *In its* Location and Navigation Satellite Systems Mar. 1989 p 353-361 In FRENCH; ENGLISH summary (For primary document see N90-23420 17-12)
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**N90-23432** Centre National d'Etudes Spatiales, Toulouse (France).
**SATELLITE ORBITOGRAPHY**
Francois Nouel *In its* Location and Navigation Satellite Systems Mar. 1989 p 363-372 In FRENCH; ENGLISH summary (For primary document see N90-23420 17-12)
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# 14 GROUND SUPPORT SYSTEMS AND FACILITIES (SPACE)

Includes launch complexes, research and production facilities; ground support equipment, e.g., mobile transporters; and simulators.

For related information see also *09 Research and Support Facilities (Air).*

**N90-23447*#** Computer Sciences Corp., Silver Spring, MD.
**GAMMA RAY OBSERVATORY (GRO) DYNAMICS SIMULATOR REQUIREMENTS AND MATHEMATICAL SPECIFICATIONS, REVISION 1**
R. Harman and D. Blejer Mar. 1990 443 p Revised
(Contract NAS5-31500)
(NASA-CR-183465; NAS 1.26:183465; FDD/554-89/002-Rev-1; CSC/TR-89/6075-Rev-1) Avail: NTIS HC A19/MF A03 CSCL 14B

The requirements and mathematical specifications for the Gamma Ray Observatory (GRO) Dynamics Simulator are presented. The complete simulator system, which consists of the profie subsystem, simulation control and input/output subsystem, truth model subsystem, onboard computer model subsystem, and postprocessor, is described. The simulator will be used to evaluate and test the attitude determination and control models to be used on board GRO under conditions that simulate the expected in-flight environment. Author

# 15 LAUNCH VEHICLES AND SPACE VEHICLES

Includes boosters; operating problems of launch/space vehicle systems; and reusable vehicles.

For related information see also *20 Spacecraft Propulsion and Power.*

**N90-23448#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**USING SIMULATION TO DETERMINE A STRATEGY FOR POSITIVELY TRACKING A CRUISE MISSILE BY CMMCA M.S. Thesis**
Antoine M. Garton Mar. 1990 117 p
(AD-A220526; AFIT/GST/ENS/90M-6) Avail: NTIS HC A06/MF A01 CSCL 17/9

Air Launched Cruise Missiles (ALCM) are frequently tested in live firings over the western United States. These test flights require the use of several aircraft for launch, tracking, and control of the test vehicles. Tracking has historically been provided by a modified EC-135 aircraft. However, an EC-18 known as the Cruise Missile Mission Control Aircraft (CMMCA) will be assuming the tracking mission. The CMMCA will use a tracking radar rather than data provided by the telemetry antenna on the EC-135 to track and keep positive control of the cruise missile. The new radar has decreased azimuth limits compared to the EC-135. Because of a mission requirement to maintain constant radar coverage of ALCM, the problem of tracking has become more difficult. A method has been developed to evaluate various options for maintaining the ALCM within the limits of the proposed radar. This method involves the use of computer simulation to model the movement of both vehicles. The modeling process is capable of employing various laws or procedures for tracking the cruise missile. This thesis describes the simulation developed for the evaluation as well as other insights gained in the evaluation process. This process should lead to a method for mission planning for CMMCA flight crews which should maximize the CMMCA's ability to provide continuous tracking coverage of the ALCM. GRA

**N90-23449#** Naval Postgraduate School, Monterey, CA. Dept. of National Security Affairs.
**BRAZIL, THE UNITED STATES, AND THE MISSILE TECHNOLOGY CONTROL REGIME Final Report, Jan. 1989 - Mar. 1990**
Scott D. Tollefson 19 Mar. 1990 118 p
(AD-A220551; NPS56-90-006) Avail: NTIS HC A06/MF A01 CSCL 16/4

This technical report analyzes Brazil's development of ballistic missiles in light of U.S. pressures to stifle that development. The first section describes and critiques the Missile Technology Control Regime (MTCR); the second analyzes the U.S. application of MTCR guidelines toward Brazil; the third assesses Brazil's ballistic missile capabilities; and the fourth considers Brazil's response. The report concludes that the U.S. policy of restricting space and missile technology to Brazil under the MTCR has succeeded in stalling Brazil's missile program, but has also: (1) further strained Brazilian security relations with the United States; (2) weakened U.S. influence over Brazil's rocket and missile programs; (3) strengthened Brazilian ties with European suppliers (especially France) of space and missile technology; (4) driven Brazil into closer technological cooperation with the People's Republic of China and the Soviet Union; and (5) intensified Brazilian negotiations with Iraq and Libya. As Brazil moves away from the United States (its traditional supplier of space and missile technology), it is becoming relatively more autonomous and less vulnerable to U.S. restrictions on space and missile technology. The successful implementation of an internationalist development strategy by Brazil's new president, Fernando Collor de Mello, could provide the United States with an exceptional opportunity to improve relations with Brazil. GRA

**N90-23450#** Aerospatiale, Les Mureaux (France). Advanced Studies Group.
**CONCEPTUAL WORK AT AEROSPATIALE ON AIR-BREATHING AND NON-AIR-BREATHING RECOVERABLE LAUNCHERS**
H. Lacaze 9 Feb. 1989 6 p Presented at the 1989 Aerospace Engineering Conference and Show, Los Angeles, CA, 14-16 Feb. 1989
(Rept-892-422-104; S/DT/F-41029; ETN-90-96628) Avail: NTIS HC A02/MF A01

The approach and results relevant to be the following concepts are summarized: rocket launchers using wing lift for recovery; airbreathers, with varying amount of rocket propulsion complement; winged upper stages, like the Hermes Spaceplane. Studies in air assisted satellite launchers take strength from recent developments like the Ariane launcher and Hermes Spaceplane and connected studies of hypersonic cruise airplane and high supersonic ramjet missiles. ESA

**N90-23451#** Aerospatiale, Les Mureaux (France).
**PREDICTION METHODS OF LAUNCHER AEROELASTIC STABILITY. APPLICATION TO THE ARIANE 5/HERMES VEHICLE. COMPARISON WITH TEST RESULTS**
D. Barthe, R. Lagier, and G. Simon 1989 13 p Presented at European Forum on Aeroelasticity and Structural Dynamics, Aachen, Fed. Republic of Germany, 17-19 Apr. 1989 Previously announced in IAA as A90-33415 Sponsored by CNES Prepared in cooperation with ONERA, Paris, France
(Rept-892-422-107; ETN-90-96631) Avail: NTIS HC A03/MF A01

Evaluation of the aeroelastic stability of the Ariane 5/Hermes vehicle in the low frequency range is presented. Two prediction methods are described, one based on the quasi-steady theory, the other using the slender bodies formulation. The prediction methods allow a computation of the aerodynamic damping and

the frequency variation of the low frequency structure eigenmodes. An application to the Hermes launch configuration for various Mach numbers is presented. The study was extended by subscale wind tunnel tests, on a mockup reproducing a few significant modes, in order to validate or update the calculation tools. Conclusions from the comparison between experimental and calculation results are given. ESA

# 16 SPACE TRANSPORTATION

Includes passenger and cargo space transportation, e.g., shuttle operations; and space rescue techniques.

For related information see also *03 Air Transportation and Safety* and *18 Spacecraft Design, Testing and Performance*. For space suits see *54 Man/System Technology and Life Support*.

**N90-23452*#** McDonnell-Douglas Space Systems Co., Washington, DC. Engineering Services.
**STUDY TO IDENTIFY FUTURE CRYOGEN PAYLOAD ELEMENTS/USERS FOR SPACE SHUTTLE LAUNCH DURING PERIOD 1990 TO 2000**
Frank M. Elim 17 Nov. 1989 30 p Sponsored by NASA, Washington, DC
(NASA-CR-186311; NAS 1.26:186311) Avail: NTIS HC A03/MF A01 CSCL 22B

This study provides a summary of future cryogenic space payload users, their currently projected needs and reported planning for space operations over the next decade. At present, few users with payloads consisting of reactive cryogens, or any cryogen in significant quantities, are contemplating the use of the Space Shuttle. Some members of the cryogenic payload community indicated an interest in flying their future planned payloads on the orbiter, versus an expendable launch vehicle (ELV), but are awaiting the outcome of a Rockwell study to define what orbiter mods and payloads requirements are needed to safely fly chemically reactive cryogen payloads, and the resultant cost, schedule, and operational impacts. Should NASA management decide in early 1990 to so modify orbiter(s), based on the Rockwell study and/or changes in national defense payloads launch requirements, then at least some cryo payload customers will reportedly plan on using the Shuttle orbiter vehicle in preference to an ELV. This study concludes that the most potential for possible future cryogenic space payloads for the Space Transportation System Orbiter fleet lies within the scientific research and defense communities. Author

**N90-23453#** Centro Italiano Ricerche Aerospaziali, Naples. Aerothermodynamics Section.
**HERMES PREPARATORY PROGRAMME: FLUIDYNAMICS STUDIES. ACTIVITIES PERFORMED BY THE ITALIAN RESEARCHERS Final Report, 1st Year Activities**
G. Russo 1 Oct. 1989 11 p
(DLC/COP-HER-TN-002; ETN-90-96558) Avail: NTIS HC A03/MF A01

First year activity in the development of the European space shuttle Hermes is reported. Different topics under investigation are listed. The main contributions given by each research are summarized. The evaluation of phenomenological coefficients for the assessement of an advanced modeling of very high Mach number gas dynamics is discussed. ESA

**N90-23454*#** Texas Univ., Austin. Dept. of Mechanical Engineering.
**DESIGN OF AN UNMANNED LUNAR CARGO LANDER THAT RECONFIGURES INTO A SHELTER FOR A HABITATION MODULE OR DISASSEMBLES INTO PARTS USEFUL TO A PERMANENT MANNED LUNAR BASE**
Lisa Davanay, Brian Garner, and Jason Rigol 1989 82 p
(Contract NASw-4435)
(NASA-CR-186687; NAS 1.26:186687) Avail: NTIS HC A05/MF A01 CSCL 22B

NASA plans to establish a permanent manned lunar base by the first decade of the twenty-first century. It is extremely expensive to transport material from earth to the moon. Therefore, expense would be reduced if the vehicle that lands cargo on the moon could itself meet some of the material needs of establishing the lunar base. The design of a multi-functional lander that is entirely useful to the base after landing is described. Alternate designs of the overall lander configuration and possible uses of the lander and its components after landing are contained. The design solution is a lander employing the Saddlebagged Fuel Tank Configuration. After landing, its structure will be converted into a habitation module shelter that supports a protective layer of regolith. The fuel tanks will be cleaned and used as storage tanks for the lunar base. The engines and instrumentation will be saved as stock parts. Recommendations for further research and technology development to enhance future lander designs are given. Author

**N90-23455*#** Pennsylvania State Univ., University Park. Dept. of Aerospace Engineering.
**PRELIMINARY SUBSYSTEM DESIGNS FOR THE ASSURED CREW RETURN VEHICLE (ACRV), VOLUMES 1-3 Final Report**
1990 579 p Conference held in Cleveland, OH, 11-15 Jun. 1990
(Contract NASw-4435)
(NASA-CR-186662; NAS 1.26:186662) Avail: NTIS HC A25/MF A03 CSCL 22B

A long term manned facility in space must include provisions for the safety of the crew. The resolution of this need was the design of an Assured Crew Return Vehicle (ACRV). The main focus is on the braking and landing system of the ACRV. This subsystem of the ACRV was divided into three phases. The Phase 1 analysis showed that the use of a tether to aid in the reentry of the ACRV was infeasible due to cost and efficiency. Therefore, a standard rocket would be used for reentry. It was also found that the continental United States was an achievable landing site for the ACRV. The Phase 2 analysis determined the L/D of the vehicle to be 1.8, thus requiring the use of a lifting body for reentry. It was also determined that shuttle tiles would be used for the thermal protection system. In addition, a parachute sequence for further deceleration was included, namely a ringslot drogue chute, a pilot chute, and finally a ringsail main parachute. This sequence was found to be capable of slowing the vehicle to a descent velocity of 9 to 10 m/s, which is the required velocity for aerial recovery. The Phase 3 analysis proved that a Sikorsky CH-53E helicopter is capable of retrieving the ACRV at 5.5 km altitude with minimal g-forces induced on the ACRV and minimal induced moments on the helicopter upon hookup. The helicopter would be modified such that it could stabilize the ACRV close to the bottom of helicopter and carry it to the nearest designated trauma center. Author

**N90-23456#** Technische Univ., Berlin (Germany, F.R.). Inst. fuer Luft- und Raumfahrt.
**FINANCING OF LARGE SPACE TRANSPORTATION PROJECTS: RESEARCH ON THE FINANCIAL PROJECT FOR THE SSPS [FINANZIERUNG VON RAUMFAHRTGROSSPROJEKTEN: ENTWICKLUNG EINER PROJEKTFINANZIERUNG FUER EIN SSPS]**
Sven Abitzsch 1989 48 p In GERMAN; ENGLISH summary
(ILR-Mitt-228(1989); ETN-90-96481) Avail: NTIS HC A03/MF A01

A method of project financing specifically developed for capital intensive projects is presented with particular consideration to the participation of private investment. The SSPS (Space Solar Power System) project was chosen for the financing model because of a promising high profit (yearly average of 219 billion dollars in 1985) and of running investments of 225 billion dollars over 22 years. The private partner is concerned in the project but not directly in the development phase. The financing model shows a great flexibility and often speeds up the project work. ESA

# 17 SPACE COMM., SPACECRAFT COMM., COMMAND & TRACKING

Includes telemetry; space communications networks; astronavigation and guidance; and radio blackout.

For related information see also *04 Aircraft Communications and Navigation* and *32 Communications and Radar.*

**N90-23457*#** Research Inst. for Advanced Computer Science, Moffett Field, CA.
**PERFORMANCE ANALYSIS OF CCSDS PATH SERVICE**
Marjory J. Johnson Apr. 1989 16 p
(Contract NCC2-387)
(NASA-CR-180699; NAS 1.26:180699; RIACS-TR-89.13) Avail: NTIS HC A03/MF A01 CSCL 09F

A communications service, called Path Service, is currently being developed by the Consultative Committee for Space Data Systems (CCSDS) to provide a mechanism for the efficient transmission of telemetry data from space to ground for complex space missions of the future. This is an important service, due to the large volumes of telemetry data that will be generated during these missions. A preliminary analysis of performance of Path Service is presented with respect to protocol-processing requirements and channel utilization. Author

**N90-23458#** Aerospatiale, Cannes (France).
**AUTONOMOUS LOW EARTH ORBIT NAVIGATION**
H. Renault, P. Maute, J. P. Jahier, and C. Jayles (Centre National d'Etudes Spatiales, Toulouse, France ) Aug. 1989 6 p Sponsored by CNES Prepared in cooperation with Electronique Serge Dassault, Saint Cloud, France
(Rept-892-440-101; CA-8/89; ETN-90-96658) Copyright Avail: NTIS HC A02/MF A01

An on-board navigation software which is presently under development is presented as follows: requirements analysis; software functional analysis; DORIS system description; navigation software description; validation; possible adaptation scheme of the software to GPS (Global Positioning System). Available of DORIS/SPOT 2 real measurements will allow convincing validation of the software and realistic evaluation of possible algorithms. Further development of this concept will be related to GPS measurement. ESA

**N90-23421** Institut Francais de Navigation, Paris.
**GENERAL INTRODUCTION TO LOCATION AND NAVIGATION CAPABILITIES**
Jean Prunieras *In* CNES, Location and Navigation Satellite Systems Mar. 1989 p 17-50 In FRENCH; ENGLISH summary (For primary document see N90-23420 17-12)
Copyright Avail: CEPADUES-Editions, 111 rue Nicolas-Vauquelin, 31100 Toulouse, France

**N90-23423** Ecole Nationale de l'Aviation Civile, Toulouse (France).
**GENERAL PRINCIPLES OF RADIONAVIGATION: SPACE MAPPING**
Jean-Louis Jonquieres *In* CNES, Location and Navigation Satellite Systems Mar. 1989 p 69-88 In FRENCH; ENGLISH summary (For primary document see N90-23420 17-12)
Copyright Avail: CEPADUES-Editions, 111 rue Nicolas-Vauquelin, 31100 Toulouse, France

**N90-23424** Centre National d'Etudes Spatiales, Toulouse (France).
**LOCATION AND NAVIGATION TECHNOLOGY: PUTTING THEORY INTO PRACTICE**
Bruno Cugny *In its* Location and Navigation Satellite Systems Mar. 1989 p 89-108 In FRENCH; ENGLISH summary (For primary document see N90-23420 17-12)
Copyright Avail: CEPADUES-Editions, 111 rue Nicolas-Vauquelin, 31100 Toulouse, France

**N90-23426** Centre National d'Etudes Spatiales, Toulouse (France).
**MEASUREMENT ERRORS**
Jean Saint-Etienne *In its* Location and Navigation Satellite Systems Mar. 1989 p 133-195 In FRENCH; ENGLISH summary (For primary document see N90-23420 17-12)
Copyright Avail: CEPADUES-Editions, 111 rue Nicolas-Vauquelin, 31100 Toulouse, France

**N90-23429** European Space Agency, Paris (France).
**BACK TO THE STARS**
Calin Rosetti *In* CNES, Location and Navigation Satellite Systems Mar. 1989 p 301-306 In ENGLISH; FRENCH summary (For primary document see N90-23420 17-12)
Copyright Avail: CEPADUES-Editions, 111 rue Nicolas-Vauquelin, 31100 Toulouse, France

**N90-23439** International Maritime Satellite Organization, London (England).
**PROSPECTS FOR INTEGRATION OF SATELLITE COMMUNICATIONS, NAVIGATION AND MONITORING FUNCTIONS**
George Kinal *In* CNES, Location and Navigation Satellite Systems Mar. 1989 p 483-496 In ENGLISH; FRENCH summary (For primary document see N90-23420 17-12)
Copyright Avail: CEPADUES-Editions, 111 rue Nicolas-Vauquelin, 31100 Toulouse, France

# 18 SPACECRAFT DESIGN, TESTING AND PERFORMANCE

Includes satellites; space platforms; space stations; spacecraft systems and components such as thermal and environmental controls; and attitude controls.

For life support systems see *54 Man/System Technology and Life Support.* For related information see also *05 Aircraft Design, Testing and Performance, 39 Structural Mechanics,* and *16 Space Transportation.*

**N90-23459*** National Aeronautics and Space Administration, Washington, DC.
**COSMIC BACKGROUND EXPLORER (COBE) PRESS KIT**
Nov. 1989 23 p
(P89-10172) Avail: Issuing Activity CSCL 22B

COBE, the Cosmic Background Explorer spacecraft, and its mission are described. COBE was designed to study the origin and dynamics of the universe including the theory that the universe began with a cataclysmic explosion referred to as the Big Bang. To this end, earth's cosmic background - the infrared radiation that bombards earth from every direction - will be measured by three sophisticated instruments: the Differential Microwave Radiometer (DMR), the Far Infrared Absolute Spectrophotometer (FIRAS), and the Diffuse Infrared Background Experiment (DIRBE). J.P.S.

**N90-23460*#** National Aeronautics and Space Administration, Washington, DC.
**SPACE STATION FREEDOM MEDIA HANDBOOK**
Apr. 1989 113 p
(NASA-TM-102901; NAS 1.15:102901) Avail: NTIS HC A06/MF A01 CSCL 22B

This handbook explains in lay terms, the work that is going on at the NASA Centers and contractors' plants in designing and developing the Space Station Freedom. It discusses the roles, responsibilities, and tasks required to build the Space Station Freedom's elements, systems, and components. New, required ground facilities are described, organized by NASA Center in order to provide a local angle for the media. Included are information on the historical perspective, international aspects, the utilization of the Space Station Freedom, a look at future possibilities, a description of the program, its management, program phases and milestones, and considerable information on the role of various

NASA Centers, contractors and international partners. A list of abbreviations, a four-page glossary, and a list of NASA contacts are contained in the appendices. J.P.S.

**N90-23461** Southampton Univ. (England).
**THE INFLUENCE OF THE GAS SURFACE INTERACTION ON SPACECRAFT ORBITAL MOTION Ph.D. Thesis**
Richard Crowther 1989 232 p
Avail: Univ. Microfilms Order No. BRDX87353

Characterization of the interaction between the neutral atmosphere in low earth orbit and spacecraft surfaces is required for a broad range of applications to system and mission definition. For the prediction of spacecraft trajectories in this free molecular regime, the nature of the interaction must be accurately modeled. Accurate definition of the interaction is also required for the design of the attitude control system for vehicles such as Space Station which will generate large aerodynamic moments. The methods available to determine this interaction indirectly from observation of the motion of a satellite are reviewed. The orbital analysis technique is chosen. Two methods of modeling complex spacecraft configurations are developed. The first, a Monte Carlo Test Particle approach, is able to account for all the phenomena characteristic of Free Molecular Flow. The second, adopting a panel method approach, accounts only for the possible shielding of surfaces from the flow. Discrepancies between the two modeling programs are identified but for the limited flow range relevant to the ANS-1 mission, good agreement is found and the computationally more efficient panel method program adopted. A new set of momentum accommodation coefficients are introduced to characterize the interaction. The theory required to represent the relationship between the changes in the spacecraft trajectory and the gas-surface interaction is then developed. The sensitivity of the derived momentum accommodation to the parameters used in the modeling process is then determined. This theory is then applied to the orbital data derived for ANS-1 (1970-70A) by ESOC. The results suggest that the nature of the interaction is close to the classical diffuse case but the accuracy of the results are limited by uncertainties in the measured changes in orbital inclination.
Dissert. Abstr.

**N90-23462*#** National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
**GEOMETRIC PROGRAMMING PREDICTION OF DESIGN TRENDS FOR OMV PROTECTIVE STRUCTURES**
R. A. Mog (Science Applications International Corp., Huntsville, AL.) and J. R. Horn Washington Jun. 1990 20 p
(NASA-TM-4206; M-632; NAS 1.15:4206) Avail: NTIS HC A03/MF A01 CSCL 22B

The global optimization trends of protective honeycomb structural designs for spacecraft subject to hypervelocity meteroid and space debris are presented. This nonlinear problem is first formulated for weight minimization of the orbital maneuvering vehicle (OMV) using a generic monomial predictor. Five problem formulations are considered, each dependent on the selection of independent design variables. Each case is optimized by considering the dual geometric programming problem. The dual variables are solved for in terms of the generic estimated exponents of the monomial predictor. The primal variables are then solved for by conversion. Finally, parametric design trends are developed for ranges of the estimated regression parameters. Results specify nonmonotonic relationships for the optimal first and second sheet mass per unit areas in terms of the estimated exponents.
Author

**N90-23463#** Naval Postgraduate School, Monterey, CA.
**OMV (ORBITAL MANEUVERING VEHICLE) PAYLOAD SUPPORT CONCEPT FOR PEGASUS BOOSTED PAYLOADS M.S. Thesis**
Ronald C. Repper Sep. 1989 85 p
(AD-A218371) Avail: NTIS HC A05/MF A01 CSCL 22/2

A new concept of orbiting and maintaining payloads in low earth orbit is examined. Two existing technologies, namely the Pegasus Air-Launched Space Booster and the Orbital Maneuvering Vehicle (OMV), are merged to create an operational space system. The boosted payload need be an autonomous satellite, as the OMV will provide all required support to the payload. This allows new satellite design, as the weight and volume of non-productive satellite subsystems can be replaced with more payload. A superior system could then be orbited while maintaining a fixed weight and volume budget. Background on the proposed concept and the OMV and Pegasus vehicles is provided. The docking and activation of the Pegasus payload to the OMV are described. A comparison of a current NOAA satellite system to the OMV/Pegasus concept is offered to determine the merits of this strategy. Conclusions and recommendations are then offered concerning the economic and operational advantages over current space systems with the implementation of this new concept.
GRA

**N90-23464#** Texas A&M Univ., College Station. Dept. of Electrical Engineering.
**NEW GENERATION POWER SUBSYSTEMS FOR SATELLITES Final Report**
Feb. 1990 307 p
(Contract N00014-89-J-2029)
(AD-A219540) Avail: NTIS HC A14/MF A02 CSCL 10/2

The feasibility was studied of increasing the specific power of satellite electric power subsystems for its operational value of 1 Watt/lb in satellites in current use to 10 Watt/lb or greater by the year 2000. The approaches which were followed include: computerized searches of various literature and patent data bases; and evaluation of inhouse information and data collections on power subsystems technologies. The technologies considered for electrical energy storage are batteries and fuel cells combined with water electrolyzers. Thermal energy storage, in conjunction with solar heat engines (dynamic solar systems) and other thermal engines are also considered. Primary electrical power sources include photovoltaics, nuclear power and advanced power system concepts. Subsystems include power conditioning, controls, and thermal management. Based on the information obtained: (1) a critical assessment of the state-of-the-art of these technologies was carried out; (2) long range research and engineering needs to achieve the project goal were identified; and (3) a time base to reach the stated goals for the three most promising technologies in the energy source and energy storage categories, was established.
GRA

**N90-23465#** Stanford Univ., CA. Dept. of Aeronautics and Astronautics.
**MODELING AND CONTROL OF FLEXIBLE VEHICLES IN SPACE Final Report, Oct. 1987 - Oct. 1989**
A. E. Bryson and F. A. Wiesinger 12 Feb. 1990 48 p
(Grant AF-AFOSR-0015-88; AF Proj. 2302)
(AD-A219622; AFOSR-90-0299TR) Avail: NTIS HC A03/MF A01 CSCL 22/2

Several aspects of modeling and control of large space structures were investigated. A FORTRAN computer program is included which transforms modal data from commercially available finite element codes for personal computers to the forms needed for control system design. Design of a low order controller for a circular flat plate space structure is investigated by utilizing geometric symmetry of the structure and the control system actuators and sensor to decouple the system into smaller, single input-single output subsystems.
GRA

**N90-23466#** Italspazio, Rome (Italy).
**ORBIT CONTROL FOR A REGIONAL NAVIGATION SYSTEM BASED ON TUNDRA ORBIT**
G. Rondinelli, A. Cramarossa, L. Caporicci, and F. Graziani (La Sapienza Univ., Rome, Italy ) 1989 12 p Presented at AIAA Guidance Navigation and Control Conference, Boston, MA, 14-16 Aug. 1989
(AIAA-89-3619; ETN-90-96554) Avail: NTIS HC A03/MF A01

Results of investigation on the control of satellites in tundra orbits are given. Maneuvers to preserve satellite subtracks in terms of longitude and synchronism and to maintain constellation

geometry in a regional bidimensional autonomous navigation service were addressed. Analyses performed are referred to a satellite lifetime 7 years. The subtrack longitude is noted to be perfectly maintained within one degree of tolerance, and an advance of the apogee passage is experienced in both satellites. Necessary delta-v and propellant mass are reported. A fuel saving allows increasing of the satellite payload configuration or design and development of small low cost satellites to be employed in navigation services. ESA

**N90-23467#** Aerospatiale, Cannes (France).
**ISO ATTITUDE AND ORBIT CONTROL SUBSYSTEM**
J. Busseuil and W. VanLeewen (Fokker B.V., Amsterdam, Netherlands) Jun. 1989 10 p Presented at 40th IAF Congress, Beijing, China, 7-12 Oct. 1989 Previously announced in IAA as A90-13496
(Rept-892-440-104; IAF-89-382; CA-6/89; ETN-90-96661)
Copyright Avail: NTIS HC A02/MF A01

The Attitude and Orbit Control Subsystem (AOCS) of the ESA Infrared Space Observatory (ISO), to be launched in 1993 is described. The typical mission characteristics are highlighted and their direct impact on the AOCS design is shown. AOCS units and architecture are reviewed. AOCS functional design is detailed (main functions in the AOCS software, AOCS modes and safeguards). The safeguard aspects driving the originality of the AOCS are outlined. Relevant simulations are shown to illustrate the design. ESA

**N90-23468#** California Univ., Los Angeles. Dept. of Electrical Engineering.
**THEORY OF FILTERING AND CONTROL WITH APPLICATION TO CONTROL OF LARGE SPACE STRUCTURES Final Report, 1 Aug. 1988 - 31 Oct. 1989**
A. V. Balakrishnan 31 Oct. 1989 11 p
(Grant AF-AFOSR-0252-88; AF Proj. 2304)
(AD-A219936; AFOSR-90-0345TR) Avail: NTIS HC A03/MF A01 CSCL 12/9

The problem of compensator design for co-located sensors using continuum models of flexible multibody systems was solved. Several nonlinear damping models for general distributed parameter systems for beam models of flexible multibody systems were developed. GRA

**N90-23469#** Texas Technological Univ., Lubbock. Dept. of Electrical Engineering.
**A THEORY OF CONTROL FOR INFINITE DIMENSIONAL SYSTEMS WITH APPLICATION TO LARGE SCALE SPACE STRUCTURES Final Report, 15 Dec. 1987 - 14 Dec. 1989**
Erol Emre Feb. 1990 34 p
(Grant AF-AFOSR-0078-88; AF Proj. 2304)
(AD-A219937; AFOSR-90-0332TR) Avail: NTIS HC A03/MF A01 CSCL 22/1

An extended and unifying system identification technique for a class of systems that include all main signal models that arise in the Harmonic Decomposition Problem has been obtained. This technique unifies and extends the previously developed system identification techniques which are improvements on the PISARENKO (MUSIC, dually) Harmonic Decomposition as they arise in arrays of sensors. The advantages of the technique and some of its specializations given here include having no assumptions of stationarity on the stochastic processes involved. Another contribution on this technique is to show that it can also be used without any resort to probability theoretic concepts, thus bypassing the approximation of autocorrelations via time averages, yielding the system parameters exactly. This techniques can be utilized to determine the dominant modes of vibrations of flexible structures as well. An analogy is established between arrays of sensors for target signal returns and those that can be used for vibrations in flexible structures. GRA

**N90-23470*#** Ohio State Univ., Columbus. Dept. of Aeronautical and Astronautical Engineering.
**PROJECT WISH: THE EMERALD CITY**
Hayrani Oz, Linda Slonksnes, ed., James W. Rogers, ed., Scott E. Sherer, ed., Michelle A. Strosky, ed., Andrew G. Szmerekovsky, ed., and G. Joseph Klupar, ed. Jun. 1990 177 p
(Contract NASw-4435)
(NASA-CR-186692; NAS 1.26:186692) Avail: NTIS HC A09/MF A01 CSCL 22B

The preliminary design of a permanently manned autonomous space oasis (PEMASO), including its pertinent subsystems, was performed during the 1990 Winter and Spring quarters. The purpose for the space oasis was defined and the preliminary design work was started with emphasis placed on the study of orbital mechanics, power systems and propulsion systems. A rotating torus was selected as the preliminary configuration, and overall size, mass and location of some subsystems within the station were addressed. Computer software packages were utilized to determine station transfer parameters and thus the preliminary propulsion requirements. Power and propulsion systems were researched to determine feasible configurations and many conventional schemes were ruled out. Vehicle dynamics and control, mechanical and life support systems were also studied. For each subsystem studied, the next step in the design process to be performed during the continuation of the project was also addressed. Author

# 19 SPACECRAFT INSTRUMENTATION

For related information see also *06 Aircraft Instrumentation* and *35 Instrumentation and Photography.*

No abstracts in this category.

# 20 SPACECRAFT PROPULSION AND POWER

Includes main propulsion systems and components, e.g., rocket engines; and spacecraft auxilliary power sources.

For related information see also *07 Aircraft Propulsion and Power, 28 Propellants and Fuels, 44 Energy Production and Conversion,* and *15 Launch Vehicles and Space Vehicles.*

**N90-23471#** Tokyo Univ. (Japan).
**ON THE SIMULATION TEST FOR THE RELATIVE MOTION OF SEPARATED SUB-BOOSTERS ON M-3S2 WITH NEARLY HALF A MODEL VEHICLE ST-735 AND THEIR MOTION ANALYSES USING INERTIAL SENSORS OUTPUT**
Shigeki Tsukamoto Feb. 1989 18 p Original contains color illustrations
(ISAS-635; ISSN-0285-6808) Avail: NTIS HC A03/MF A01

In the course of development of the M-3S2 type vehicle which has two relatively large sub-boosters, a possibility of collision between the separated sub-booster and the core-motor was discussed with concern especially in relation to the effect of the core-motor plume. A flight simulation test was performed with the ST-735, a nearly half-scale model of M-3S2, under the conditions specified by a similarity law for the motion of the separated sub-booster. The relative motion of the sub-booster was analyzed with on board TV, inertial sensors, and a device for measuring separation distance. Although TV pictures provide real time, high speed images of the sub-booster, only 2-dimensional information is obtained in principle. Analysis of the motion with 12 inertial sensors provides the complete 3-dimensional motion of the sub-booster. The test predicts that the exhaust plume would not influence the motion of the separated sub-boosters in M-3S2 flight. Author

**N90-23472** Pennsylvania State Univ., University Park.
**EXPERIMENTAL STUDY OF MIXING AND COMBUSTION PROCESSES IN A SOLID-PROPELLANT DUCTED ROCKET MOTOR Ph.D. Thesis**
Chin-Lung Chuang 1989 178 p
Avail: Univ. Microfilms Order No. DA8922034

Solid-propellant ducted rocket (SDR) was long considered as a promising air-breathing propulsion system due to its high propulsion performance. The physical-chemical processes involved in the mixing and combustion processes in SDR combustion chambers are extremely complicated. Current literature on SDR systems sheds little light on these complex flow phenomena. Furthermore, the few available computational analyses of this problem are yet to be validated due to the lack of suitable experimental data. The purpose of this experimental investigation is to achieve a better understanding of the mixing and combustion processes in SDR combustion chambers. Several flow visualization techniques, including schlieren photography, laser light-sheet, and surface flow visualization techniques, are employed to study the cold flow characteristics in various SDR combustion chambers. Both two- and three-dimensional cases are investigated. In addition, a Laser Doppler Velocimeter (LDV) system is used for the measurement of cold flow velocities and turbulence correlations within the SDR combustor. Instrumentation is also set up to measure the pressure, temperature, and flow rates of the gases in the vitiator, gas generator, and main combustor for cases with combustion. A manual/auto control system for compressed air together with a liquid fuel supply system were also designed and developed. The qualitative results obtained from the schlieren, laser light-sheet, and surface flow visualizations, and the quantitative data obtained from the laser Doppler velocimetry measurements and combustion tests are not only helpful in understanding the mixing processes and flow structures in the combustor, but are also useful for partial validation of a theoretical model developed in a parallel program of the same research team. The experimental data are in good agreement with the predictions of the theoretical model. Dissert. Abstr.

**N90-23473#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**ANALYSIS OF THE USE OF A METHANE PROPELLANT IN A BIOWASTE RESISTOJET M.S. Thesis**
John A. Vise Mar. 1990 119 p
(AD-A220475; AFIT/GA/ENY/90M-2) Avail: NTIS HC A06/MF A01 CSCL 21/3

An engineering model resistojet has been developed by NASA for possible space station applications that will operate on a variety of waste gases, including methane. This investigation develops a computer program using the principles of laminar flow heat transfer to simulate operation of the resistojet heat exchanger. The principles of chemical kinetics are used to determine how carbon deposits from methane decomposition in the heat exchanger. The results of the program show a wide variation in deposition versus operational pressure, power, and methane mass flow rate. GRA

**N90-23474*#** Little (Arthur D.), Inc., Cambridge, MA.
**CONCEPTUAL DESIGN OF A MOVING BELT RADIATOR (MBR) SHUTTLE-ATTACHED EXPERIMENT Final Report**
Jerry L. Aguilar Jun. 1990 46 p
(Contract NAS3-25356)
(NASA-CR-185169; NAS 1.26:185169) Avail: NTIS HC A03/MF A01 CSCL 21H

The conceptual design of a shuttle-attached Moving Belt Radiator (MBR) experiment is presented. The MBR is an advanced radiator concept in which a rotating belt is used to radiate thermal energy to space. The experiment is developed with the primary focus being the verification of the dynamic characteristics of a rotating belt with a secondary objective of proving the thermal and sealing aspects in a reduced gravity, vacuum environment. The mechanical design, selection of the belt material and working fluid, a preliminary test plan, and program plan are presented. The strategy used for selecting the basic sizes and materials of the components are discussed. Shuttle and crew member requirements are presented with some options for increasing or decreasing the demands on the STS. An STS carrier and the criteria used in the selection process are presented. The proposed carrier for the Moving Belt Radiator experiment is the Hitchhiker-M. Safety issues are also listed with possible results. This experiment is designed so that a belt can be deployed, run at steady state conditions, run with dynamic perturbations imposed, verify the operation of the interface heat exchanger and seals, and finally be retracted into a stowed position for transport back to earth. Author

# 23 CHEMISTRY AND MATERIALS (GENERAL)

**N90-23475*** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**SOME 1-(DIORGANOOXYPHOSPHONYL)METHYL-2,4- AND -2,6-DINITRO-BENZENES Patent**
John A. Mikroyannidis, inventor (to NASA) (Patras Univ., Greece ) and Demetrius A. Kourtides, inventor (to NASA) 12 Dec. 1989 7 p Filed 28 May 1987 Division of US-Patent-Appl-SN-641152, filed 16 Aug. 1984 which is a continuation-in-part of abandoned US-Patent-Appl-SN-522629, filed 12 Aug. 1983 which is a continuation-in-part of abandoned US-Patent-Appl-SN-493864, filed 12 May 1983
(NASA-Case-ARC-11425-3; US-Patent-4,886,896; US-Patent-Appl-SN-054982; US-Patent-Appl-SN-641152; US-Patent-Appl-SN-522629; US-Patent-Appl-SN-493864; US-Patent-Class-558-193; Int-Patent-Class-C07S-9/40) Avail: US Patent and Trademark Office CSCL 07A

1-(Diorgano oxyphosphonyl) methyl) 2,4- and 2,6-dinitro- and diamino benzenes are prepared by nitrating an (organophosphonyl)methyl benzene to produce the dinitro compounds which are then reduced to the diamino compounds. The organo group (alkyl, haloalkyl, aryl) on the phosphorus may be removed to give the free acids, (HO)2P(double bond O) single bond. The diamino compounds may be polymerized with dianhydrides or diacyl halides to produce fire and flame resistant polymers which are useful in the manufacture of aircraft structures.
Official Gazette of the U.S. Patent and Trademark Office

**N90-23476*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**DEVELOPMENT OF A QUADRUPOLE-BASED SECONDARY-ION MASS SPECTROMETRY (SIMS) SYSTEM AT LEWIS RESEARCH CENTER**
Carlos Vargas-Aburto, Paul R. Aron, and Dale R. Liff (Kent State Univ., OH.) Jun. 1990 32 p
(NASA-TM-102531; E-5341; NAS 1.15:102531) Avail: NTIS HC A03/MF A01 CSCL 07A

The design, construction, and initial use of an ion microprobe to carry out secondary ion mass spectrometry (SIMS) of solid samples is reported. The system is composed of a differentially pumped custom-made UHV (Ultra High Vacuum) chamber, a quadrupole mass spectrometer and a telefocus A-DIDA ion gun with the capability of producing beams of Cesium, as well as inert and reactive gases. The computer control and acquisition of the data were designed and implemented using a personal computer with plug-in boards, and external circuitry built as required to suit the system needs. The software is being developed by using a FORTH-like language. Initial tests aimed at characterizing the system, as well as preliminary surface and depth-profiling studies are presently underway. Author

# 24 COMPOSITE MATERIALS

Includes physical, chemical, and mechanical properties of laminates and other composite materials.
For ceramic materials see *27 Nonmetallic Materials*.

**N90-23477*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**STRUCTURAL BEHAVIOR OF COMPOSITES WITH PROGRESSIVE FRACTURE**
Levon Minnetyan (Clarkson Univ., Potsdam, NY.), Christos C. Chamis, and Pappu L. N. Murthy Jan. 1990 19 p Original contains color illustrations
(NASA-TM-102370; E-5089; NAS 1.15:102370) Avail: NTIS HC A03/MF A01; 10 functional color pages CSCL 11D

Structural characteristics such as natural frequencies and buckling loads with corresponding mode shapes were investigated during progressive fracture of multilayer, angle-plied polymer matrix composites. A computer program was used to generate the numerical results for overall mechanical response of damaged composites. Variations in structural characteristics as a function of the previously applied loading were studied. Results indicate that most of the overall structural properties were preserved throughout a significant proportion of the ultimate fracture load. For the cases studied, changes in structural behavior began to occur after 70 percent of the ultimate fracture load was applied. However, the individual nature of the structural change was rather varied depending on the laminate configuration, fiber orientation, and the boundary conditions. Author

**N90-23478** Pennsylvania State Univ., University Park.
**PLY CRACKING IN COMPOSITE LAMINATES Ph.D. Thesis**
Young-Myong Han 1989 139 p
Avail: Univ. Microfilms Order No. DA9007861

Ply cracking behavior and accompanying stiffness changes in thermoset as well as thermoplastic matrix composites under various loading conditions are investigated. Specific topics addressed are: analytical model development for property degradations due to ply cracking under general in-plane loading; crack initiation and multiplication under static loading; and crack multiplication under cyclic loading. A model was developed to calculate the energy released due to ply cracking in a composite laminate subjected to general in-plane loading. The method is based on the use of a second order polynomial to represent the crack opening displacement and the concept of a through-the-thickness inherent flaw. The model is then used in conjunction with linear elastic fracture mechanics to predict the progressive ply cracking as well as first ply cracking. A resistance curve for crack multiplication is proposed as a means of characterizing the resistance to ply cracking in composite laminates. A methodology of utilizing the resistance curve to assess the crack density or overloading is also discussed. The method was applied to the graphite/thermoplastic polyimide composite to predict progressive ply cracking. However, unlike the thermoset matrix composites, a strength model is found to fit the experimental results better than the fracture mechanics based model. A set of closed form equations is also developed to calculate the accompanying stiffness changes due to the ply cracking. The effect of thermal residual stress is included in the analysis. A new method is proposed to characterize transverse ply cracking of symmetric balanced laminates under cyclic loading. The method is based on the concept of a through-the-thickness inherent flaw, the Paris law, and the resistance curve. Only two constants are needed to predict the crack density as a function of fatigue cycles. Dissert. Abstr.

**N90-23479#** Oak Ridge National Lab., TN. Metals and Ceramics Div.
**MICRO-MECHANICAL MODELING OF CRACK GROWTH RESISTANCE IN A CARBON/CARBON COMPOSITE**
Michael G. Jenkins, Asish Ghosh, and Akimitsu Okura (Tokyo Univ., Japan ) 1990 13 p Presented at the International Conference on Micromechanics of Failure of Quasi-Brittle Materials, Albuquerque, NM, 7-8 Jun. 1990
(Contract DE-AC05-84OR-21400)
(DE90-009407; CONF-9006122-5) Avail: NTIS HC A03/MF A01

Micro-mechanics fracture models are incorporated into three distinct fracture process zones which contribute to the crack growth resistance of fibrous composites. The frontal process zone includes micro-cracking, fiber debonding, and some fiber failure. The elastic process zone is related only to the linear elastic creation of new matrix and fiber fracture surfaces. The wake process zone includes fiber bridging, fiber pullout, and fiber breakage. The R-curve predictions of the numerical model compare well with empirical results for a unidirectional (UD), continuous fiber C/C composite. Separating the contributions of each process zone reveals the wake region to contain the dominant crack growth resistance mechanisms. DOE

**N90-23480*** National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
**HIGH TEMPERATURE INSULATION BARRIER COMPOSITE Patent**
Joseph W. Onstott, inventor (to NASA) (Rockwell International Corp., Canoga Park, CA.) 31 Oct. 1989 6 p Filed 30 Sep. 1988
(NASA-Case-MFS-29241-1; US-Patent-4,877,689; US-Patent-Appl-SN-252078; US-Patent-Class-428-607; US-Patent-Class-428-623; US-Patent-Class-428-627; US-Patent-Class-428-632; US-Patent-Class-428-666; US-Patent-Class-428-680; US-Patent-Class-244-158A) Avail: US Patent and Trademark Office CSCL 11D

A composite material suitable for providing insulation for the nozzle structure of the Space Shuttle and other similar surfaces is disclosed. The composite layer is comprised of an outer skin layer of nickel chromium and an interleaved inner region comprising a top layer of nickel chromium foil which acts as a primary convective shield. There are at least two layers of alumina batting adjacent to the layers of silicon carbide fabric. An additional layer of nickel chromium foil is used as a secondary convective shield. The composite is particularly advantageous for use as nozzle insulation because of its ability to withstand high reentry temperatures, its flexibility, oxidation resistance, low conductivity, and light weight.
Official Gazette of the U.S. Patent and Trademark Office

**N90-23481#** Defence Research Establishment, Ottawa (Ontario). Environmental Protection Section.
**COMPARISON OF GORETEX LAMINATED AND DERMOFLEX COATED FABRICS**
P. A. Dolhan Sep. 1989 20 p
(AD-A219383; DREO-TN-90-1) Avail: NTIS HC A03/MF A01 CSCL 11/4

Two fabrics, a polyester/cotton fabric laminated with Goretex, and a nylon fabricated coated with Dermoflex, were proposed for the prototype Arctic clothing system. Samples of each fabric were subjected to various physical tests, both before and after laundering, at room temperature and at -40 C to determine the durability of the fabrics. Prototype garments made of the nylon fabric were laundered to determine the durability and effects of laundering on the construction. Donning and doffing of the prototype system was performed at 0 C and at -40 C. GRA

**N90-23482#** Akron Univ., OH. Polymer Engineering Center.
**RHEOLOGICAL AND MECHANICAL CHARACTERISTICS OF POLY-P-PHENYLENE TEREPHTHALAMIDE/NYLON MOLECULAR AND PARTICULATE COMPOSITES**
H.-S. Park and T. Kyu Dec. 1989 12 p
(Contract DAAG29-85-K-0219)
(AD-A219562; ARO-21822.3-MS) Avail: NTIS HC A03/MF A01 CSCL 11/4

Poly-p-phenylene terephthalamide (PPTA) and nylons (nylon 6, 66, 11, and 12) molecular and particulate composites were examined with emphasis on rheological, mechanical, and morphological characteristics. These molecular composites were prepared by coagulation in water from isotropic ternary sulfuric

acid solutions. Upon heating above the crystal melting temperatures of nylons, the molecular composites undergo phase separation and become two-phase particulate composites. Shear viscosity measurements indicate that the viscosity of nylon 6 and 66 systems has increased for an order of magnitude because of the presence of PPTA, but decreased in the case of nylon 11 and 12 systems. PPTA/nylon 6 and 66 systems exhibit yield behavior, particularly with high PPTA contents. Measurements show an extrudate swell of around 1 in all composition ranges and shear rates. Scanning electron microscopic investigations of low PPTA content particulate composites reveal spherical or long fibrillar morphology of PPTA phase dispersed in nylon matrices. Wide angle x ray diffraction investigations show no preferred orientation in the extrudates, but biaxial orientation in the case of compressed films. The study on mechanical properties of extrudates of 5 to 10 wt. percent PPTA compositions exhibits significant improvement in tensile modulus and tensile strength. The heat treated extrudates show further increase in tensile modulus and tensile strength, as compared with the unannealed samples, but the elongation at break decreases. GRA

**N90-23483#** Drexel Univ., Philadelphia, PA.
**MTS HIGH TEMPERATURE TESTING SYSTEM Final Technical Report, 1 Oct. 1988 - 31 Sep. 1989**
A. S. D. Wang and Michael Barsoum 30 Jan. 1990 5 p
(Grant AF-AFOSR-0122-89; AF Proj. 3842)
(AD-A219613; AFOSR-90-0284TR) Avail: NTIS HC A01/MF A01 CSCL 20/13

The MTS High Temperature Testing System which was funded by AFSOR under the DURIP Program and installed at Drexel University is described. This testing system is dedicated exclusively for basic studies on the micromechanics behaviors of fiber-reinforced ceramic matrix composites under extreme temperature conditions. Owing to its very high temperature capability and versatility to perform tests in several testing configurations, this equipment has casted a positive impact on current AFOSR and other DOD funded research programs on ceramic-matrix composites conducted at Drexel University. It is the intention to continue further developing the high-temperature mechanics capacity for the next generation of composite materials. GRA

**N90-23484#** Georgia Tech Research Inst., Atlanta.
**ULTRAFINE MICROSTRUCTURE COMPOSITES PREPARED BY CHEMICAL VAPOR DEPOSITION Final Report, Jan. 1987 - Dec. 1989**
W. J. Lackey, Garth B. Freeman, John A. Hanigofsky, John R. Thompson, Geoving J. Gerard, Woo Y. Lee, Pradeep K. Agrawal, Douglas J. Twait, Thomas S. Moss, III, and Andrew J. Green (Georgia Inst. of Tech., Atlanta.) Dec. 1989 308 p
(Contract N00014-87-K-0036)
(AD-A219650; GTRI-A-4699-3) Avail: NTIS HC A14/MF A02 CSCL 11/2

In recent years material requirements have become more strict and sophisticated for many novel applications such as space vehicles, ultrasonic jets, ceramic heat engines, high performance cutting tools, etc. It is of great interest to prepare advanced ceramics that possess high temperature stability and strength. A major difficulty exists, however, as the traditional brittleness of ceramics often causes catastrophic failures, thus, limiting their wide usage. Dispersed phase ceramic composites appear to be one solution to this problem. The composites usually possess superior mechanical properties (e.g., fracture toughness, strength, resistance to wear and erosion, hardness, etc.) compared to those of single phase ceramics. The performance of dispersed phase ceramic composites is strongly related to their microstructures. Chemical vapor deposition (CVD) offers an alternative avenue of preparing ceramic composite in the form of coatings by either simultaneous deposition of multiple phases (i.e., codeposition) or by alternately depositing several phases. The major advantage of preparing phase ceramic composites by CVD is that mechanical as well as chemical, electrical, optical and thermal properties of the composites can be favorably tailored by controlling their composition and microstructure. The desired microstructure can be achieved by optimization of CVD process variables such as temperature, pressure, reagent concentration, substrate type, reactor geometry, etc. GRA

**N90-23485#** Army Materials Technology Lab., Watertown, MA. Ceramics Research Branch.
**THE MICROWAVE PERMEABILITY OF CONDUCTING SPHERICAL SHELLS Final Report**
Hoton How, William A. Spurgeon, and Carmine Vittoria (Northeastern Univ., Boston, MA.) Feb. 1990 20 p
(DA Proj. 1L1-62105-AH-84)
(AD-A220746; MTL-TR-90-7) Avail: NTIS HC A03/MF A01 CSCL 20/3

A derivation of an expression for the microwave permeability of a conducting spherical shell analogous to currently available expressions for the permeability of a solid particle is presented in this report. The dependence of the permeability of composites of such particles on shell diameter, thickness, and conductivity for several model systems is explored. A subsequent article will examine the agreement between the models and the experimental data. GRA

**N90-23486#** Army Materials Technology Lab., Watertown, MA. Materials Science Branch.
**EFFECT OF SURFACE OXYGEN ON ADHESION OF CARBON FIBER-REINFORCED COMPOSITES Final Report**
Pearl W. Yip and Sin-Shong Lin Feb. 1990 14 p Presented at the 1989 Materials Research Society Fall Meeting, Boston, MA, 28 Nov. 1989 Sponsored by Army Lab. Command, Adelphi, MD
(AD-A220777; MTL-TR-90-9) Avail: NTIS HC A03/MF A01 CSCL 11/4

Five carbon fibers from different precursors were surface treated by various chemical reagents for the elucidation of the mechanism involved in the interfacial adhesion. SEM, ESCA, and SAM techniques were used to characterize morphology, as well as surface constituents of the treated fibers. The transverse tensile strengths of the composites made from the treated fibers and epoxy resin were also obtained. The result indicated that the interlocking mechanism by surface roughness seemed to play a major role in the fiber-epoxy adhesion. GRA

**N90-23487#** Simmonds Precision Products, Inc., Vergennes, VT. Inst. Systems Div.
**COMPOSITE INTEGRITY MONITORING Final Report, Sep. 1987 - Aug. 1988**
Robert Rudd and Kim Goddard May 1989 79 p
(Contract F33615-87-C-3241)
(AD-A220813; WRDC-TR-89-3031) Avail: NTIS HC A05/MF A01 CSCL 11/4

Optical fibers were embedded in graphite epoxy composite coupons and I-beams with the objective of measuring integrated and distributed loads. Polarimetric techniques using both high and low birefringence optical fibers were used for integrated strain, while optical time domain reflectometry (OTDR) was used for locating distributed point loads. Polarimetric results agreed favorably with resistance strain gage data when the structure applied load normal to the optical fiber axis. Stresses of 64 ksi were required to observe loads using OTDR with a resolution of 1.2 meters. GRA

**N90-23488#** Aeronautical Research Inst. of Sweden, Stockholm. Dept. of Structures.
**IMPACT RESPONSE OF ORTHOTROPIC COMPOSITE PLATES PREDICTED BY A ONE-PARAMETER DIFFERENTIAL EQUATION**
Robin Olsson Nov. 1989 83 p
(Contract FMV-82250-86-169-25-001)
(FFA-TN-1989-07; ETN-90-96598) Avail: NTIS HC A05/MF A01

An approximate analytical model for the dynamic response of a specially orthotropic composite plate impacted by an impactor with a semi-spherical tip following a Hertzian contact law is

presented. The time-history of the response is expressed in terms of contact force, contact pressure, maximum average shear stress, central displacement and central curvature. The response is computed from the numerical solution of a dimensionless differential equation in time which is dependent only on dimensionless time and a single problem parameter lambda. Lambda is a function of variables describing the impactor, impact velocity and plate. Although the basic equation is solved numerically, future calculations can be made from the plotted solution for a number of representative values of lambda. Results computed from the present model are compared with two existing FE-analyses, one other numerical model and two experiments. In general, the correlation is found to be good. The model is used to show the time-dependent velocity of a flexural wave propagating from an impact center. ESA

**N90-23489#** Aerospatiale Aquitaine, Saint-Medard en Jalles (France). Space and Strategic System Div.
**RECENT IMPLEMENTATIONS ON CERAMIC COMPOSITES AND THERMOSTRUCTURAL MATERIALS**
Jean F. Jamet 1989 24 p Presented at 40th IAF Congress, Malaga, Spain, 8-13 Oct. 1989 Previously announced in IAA as A90-13451
(Rept-892-430-106; IAF-89-318; ETN-90-96637) Avail: NTIS HC A03/MF A01

An analysis of microstructural rupture of reinforced carbon and ceramics are carried out. The evolution of models describing this rupture and the new approaching experimental methods were studied. The following are presented: the rules driving the interactions between microstructures and rupture; the consequences of industrial processing and uses; the main implementations recently obtained in terms of processing and performance either on ceramic composites and carbon-carbon protection. ESA

**N90-23490#** Aerospatiale, Paris (France). Space and Strategic Systems Div.
**COMPOSITE CURING: A NEW PROCESS**
D. Beziers and J. P. Denost Jul. 1989 10 p
(Rept-892-430-114; ETN-90-96645) Copyright Avail: NTIS HC A02/MF A01

A composite curing process based on the use of specific resin systems which are cured by a high energy electron beam is described. Reduction of curing time and cancellation of curing with temperature gives a decrease in man hours and simplifies the tools, loading to reduced costs. Burst pressure tests on different carbon filament wound vessels demonstrated the complete control of the process. A facility to cure large size structures was built. Research is ongoing in the high temperature composites and specific carbon fiber sizing fields. ESA

**N90-23491#** Aerospatiale, Paris (France).
**THERMOMECHANICAL PROPERTIES OF NEW COMPOSITE MATERIALS SIC/GLASS-CERAMIC [PROPRIETES THERMOMECANIQUES DE NOUVEAUX MATERIAUX COMPOSITES SIC/VITROCERAMIQUE]**
E. Menessier, A. Guette, R. Pailler, R. Naslain (Laboratoire de Chimie du Solide du CNRS, Talence, France ), and P. Lespade 20 Mar. 1989 8 p Presented at ECCM-3, Bordeaux, France, 20-23 Mar. 1989
(Rept-892-430-118; ETN-90-96649) Avail: NTIS HC A02/MF A01

Pseudo-unidirectional composites made of SiC Nicalon fibers and LAS (lithium alumino silicate) glass-ceramic matrix were obtained via a low temperature solgel/hot pressing route. The fibers were coated with a thin layer of pyrocarbon in order to promote fiber pull out. The elastic constant C(ij) matrix and engineering elastic moduli at room temperature were derived from wave propagation experiments. The failure strength was measured for different processing conditions through three point bending testing. The failure energy and dynamic toughness were calculated from instrumented CHARPY test data. Thermal expansion experiments were performed on both unreinforced LAS matrix and SiC/LAS composites. ESA

**N90-23492*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**RATE DEPENDENT CONSTITUTIVE MODELS FOR FIBER REINFORCED POLYMER COMPOSITES**
Thomas S. Gates May 1990 30 p
(NASA-TM-102665; NAS 1.15:102665) Avail: NTIS HC A03/MF A01 CSCL 11D

A literature survey was conducted to assess the state-of-the-art in rate dependent constitutive models for continuous fiber reinforced polymer matrix composite (PMC) materials. Several recent models which include formulations for describing plasticity, viscoelasticity, viscoplasticity, and rate-dependent phenomenon such as creep and stress relaxation are outlined and compared. When appropriate, these comparisons include brief descriptions of the mathematical formulations, the test procedures required for generating material constants, and details of available data comparing test results to analytical predictions. Author

**N90-23493*** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**ONE STEP HIP CANNING OF POWDER METALLURGY COMPOSITES Patent**
John J. Juhas, inventor (to NASA) 27 Feb. 1990 8 p Filed 21 Mar. 1989
(NASA-Case-LEW-14719-1; US-Patent-4,904,538; US-Patent-Appl-SN-326757; US-Patent-Class-428-552; US-Patent-Class-75-228; US-Patent-Class-428-551; US-Patent-Class-419-8; US-Patent-Class-419-24; US-Patent-Class-419-36; US-Patent-Class-419-37) Avail: US Patent and Trademark Office CSCL 11D

A single step is relied on in the canning process for hot isostatic pressing (HIP) powder metallurgy composites. The binders are totally removed while the HIP can of compatible refractory metal is sealed at high vacuum and temperature. This eliminates outgassing during hot isostatic pressing.
Official Gazette of the U.S. Patent and Trademark Office

**N90-23494*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA. Dept. of Materials Engineering Science.
**INSTABILITY-RELATED DELAMINATION GROWTH OF EMBEDDED AND EDGE DELAMINATIONS Ph.D. Thesis - Virginia Polytechnic Inst. and State Univ.**
John D. Whitcomb Aug. 1988 199 p Previous language document was announced as N88-26406
(NASA-TM-100655; NAS 1.15:100655) Avail: NTIS HC A09/MF A02 CSCL 11D

Compressive loads can cause local buckling in composite laminates that have a near surface delamination. This buckling causes load redistribution and secondary loads, which in turn cause interlaminar stresses and delamination growth. The goal of this research was to enhance the understanding of this instability-related delamination growth in laminates containing either an embedded or an edge delamination. Author

**N90-23495#** Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.).
**DEMONSTRATION CENTERS FOR FIBER REINFORCED MATERIALS [DEMONSTRATIONSZENTREN FUER FASERVERBUNDWERKSTOFFE]**
30 Oct. 1989 49 p In GERMAN
(Rept-45/89; ETN-90-96450) Avail: NTIS HC A03/MF A01

A review of the present use of fiber reinforced materials in industry is presented. Seven centers in West Germany are intended to provide related information business with particular consideration to the machine manufacturing. Some important properties of the fiber reinforced materials are depicted, such as stiffness and toughness, elasticity and thermic dilatation, which is particulary interesting for satellites and antennas. The problem of isotropy is

discussed. Condensation, poly-addition and polymerization resins are described. ESA

**N90-23496#** Ecole Centrale de Lyon (France).
**FRICTION AND WEAR OF TUNGSTEN CARBIDES WITH NITROGEN ION IMPLANTS Ph.D. Thesis [FROTTEMENT ET USURE DES CARBURES DE TUNGSTENE IMPLANTES D'IONS AZOTE]**
Ahmed Belbah 1989 125 p In FRENCH
(ECL-89-19; ETN-90-96940) Avail: NTIS HC A06/MF A01

The use of nitrogen ion implantation in tungsten carbides to improve wear resistance is investigated. The optimal nitrogen profiles in terms of such parameters as energy and ion flow are presented. An analysis of surface layers of the tungsten carbide is carried out using a scanning electron microscope and grazing x ray diffraction. The behavior of tungsten carbides submitted to wear tests is analyzed in terms of the amount of nitrogen ions and cobalt contained, the type of wear to which it was submitted, etc. The optimal nitrogen ion implantation values to best match different types of wear environments are presented. ESA

# 25 INORGANIC AND PHYSICAL CHEMISTRY

Includes chemical analysis, e.g., chromatography; combustion theory; electrochemistry; and photochemistry.

For related information see also *77 Thermodynamics and Statistical Physics.*.

**N90-23497*** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**SUBSTITUTED 1,1,1-TRIARYL-2,2,2-TRIFLUOROETHANES AND PROCESSES FOR THEIR SYNTHESIS Patent**
William B. Alston, inventor (to NASA) and Roy F. Gratz, inventor (to NASA) (Mary Washington Coll., Fredricksburg, VA.) 5 Dec. 1989 12 p Filed 23 Feb. 1988 Division of US-Patent-Appl-SN-924474, filed 29 Oct. 1986
(NASA-Case-LEW-14345-2; US-Patent-4,885,116; US-Patent-Appl-SN-159071; US-Patent-Appl-SN-924474; US-Patent-Class-562-413; US-Patent-Class-260-395; US-Patent-Class-260-386; US-Patent-Class-549-241; US-Patent-Class-562-415; US-Patent-Class-562-417) Avail: US Patent and Trademark Office CSCL 07D

Synthetic procedures are disclosed for tetraalkyls, tetraacids, and dianhydrides substituted 1,1,1-triaryl 2,2,2-trifluoroethanes which comprises: (1) 1,1-bis (dialkylaryl) 1-aryl 2,2,2-trifluoroethane, (2) 1,1-bis (dicarboxyaryl) 1-aryl 2,2,2-trifluoroethane, or (3) cyclic dianhydride or diamine of 1,1-bis (dialkylaryl) 1-aryl 2,2,2-trifluoroethanes. The synthesis of (1) is accomplished by the condensation reaction of an aryltrifluoromethyl ketone with a dialkylaryl compound. The synthesis of (2) is accomplished by the oxidation of (1). The synthesis dianhydride of (3) is accomplished by the conversion of (2) to its corresponding cyclic dianhydride. The synthesis of the diamine is accomplished by the similar reaction of an aryltrifluoromethyl ketone with aniline or aklyl substituted or disubstituted anilines. Also, other derivatives of the above are formed by nucleophilic displacement reactions.
Official Gazette of the U.S. Patent and Trademark Office

**N90-23498#** Defence Research Establishment Atlantic, Dartmouth (Nova Scotia).
**QUANTITATIVE DETERMINATION OF 1, 2-ETHANEDIOL CONTAMINATION IN USED DIESEL LUBRICATING OILS BY GAS CHROMATOGRAPHY/MASS SPECTROMETRY**
John A. Hiltz and John J. Power Dec. 1989 23 p
(AD-A218592; DREA-TM-89/227) Avail: NTIS HC A03/MF A01 CSCL 11/8

A quantitative method for the determination of 1,2-ethanediol (ethylene glycol) in used diesel lubricating oils is described. The method involves derivatization of the glycol with a proprietary silylating reagent, TRISYL(TM)Z, to improve the chromatography of the glycol on a non-polar capillary column. Separation, detection and quantitative analysis of the trimethylsilyl derivative of the glycol, namely, 2,2,7,7-tetramethyl-3,6-dioxa-2,7-disilaoctane, was carried out using capillary gas chromatography/mass spectrometry. The response of the trimethylsilyl derivative of 1,2-ethanediol was found to be linear over the concentration range studied, that is, from 10 parts per million (ppm) to 10000 ppm (0.001 to 1.0 percent) by weight 1,2-ethanediol in diesel lubricating oil. The minimum detectable quantity of the derivative, using the conditions described in the text, was found to be approximately 2 ppm by weight. GRA

**N90-23499#** Pennsylvania State Univ., University Park.
**THE EFFECT OF CATALYSTS ON GAS-PHASE HYDROCARBON IGNITION Final Report, 1 Mar. 1985 - 30 Aug. 1989**
Domenic A. Santavicca and Wonnam Lee 31 Jan. 1990 15 p
(Contract DAAG29-85-K-0043)
(AD-A218775; ARO-21763.5-EG) Avail: NTIS HC A03/MF A01 CSCL 21/2

The effect of catalysts on the ignition of hydrocarbon fuels was experimentally studied in a high pressure chemical flow reactor under low heat-loss Diesel engine simulated conditions. The objective of this study was to characterize the nature and magnitude of the catalytic reactions and their effect on the gas-phase ignition chemistry. Platinum, Cr2O3 (chromium oxide), and PSZ (partially stabilized zirconia) catalysts were tested with propane, propylene, n-hexane, toluene, and n-hexane/toluene mixture fuels. The parameters which were investigated include fuel structure, equivalence ratio, temperature, and pressure. With platinum, evidence of both thermal and chemical enhancement of the gas-phase ignition chemistry was observed at 6 and 10 atm under mass transport limited conditions. Thermal enhancement due to chemical heat release from the catalytic surface reactions was observed for most cases, but is most significant for near stoichiometric and fuel rich conditions. GRA

**N90-23500#** Utah Univ., Salt Lake City. Dept. of Chemistry.
**LASER TEMPERATURE-JUMP KINETIC STUDIES OF FAST REACTIONS IN NONAQUEOUS SOLUTIONS Final Report, Sep. 1987 - Feb. 1990**
Edward M. Eyring 28 Feb. 1990 6 p
(Contract N00014-86-K-0639)
(AD-A218819) Avail: NTIS HC A02/MF A01 CSCL 07/4

Ultrasonic absorption methods have elucidated the kinetics of complexation of lithium ions by cyclic and acyclic polyethers in nonaqueous solvents. The interaction between the cation and polyether chain is localized and does not depend on chain length. Stability constants for lithium-ion-crown-ether complexes in a room temperature molten salt were determined by lithium-7 nmr. Error estimation using the sequential simplex method in nonlinear curve-fitting was demonstrated on small computers. GRA

**N90-23501#** Minnesota Univ., Minneapolis. Corrosion Research Center.
**MORPHOLOGY CHANGES DUE TO OXIDATIVE TREATMENT OF GLASSY CARBON ELECTRODES AND ITS APPLICATIONS Technical Report, 1 Jan. 1989 - 25 Jan. 1990**
Ali Firouzi, Katsuhiko Naoi, and William H. Smyrl 25 Jan. 1990 3 p
(Contract N00014-88-K-0360)
(AD-A219425; TR-23-ONR) Avail: NTIS HC A01/MF A01 CSCL 07/4

Oxidative (anodic) treatment of glassy carbon (GC) in aqueous alkaline media was found to cause the formation of a unique mesa morphology. Injection of some species (perhaps OH(-)) below the surface with attendant volume change was suspected to be the cause for the peculiar morphological change. The present paper reports the mechanism of the mesa formation and its application to enhance the catalytic activity for electropolymerization of conducting polymers and the double-layer capacitance of the resulting polypryrrole/GC film. GRA

**N90-23502#** Minnesota Univ., Minneapolis. Corrosion Research Center.
**QUARTZ CRYSTAL MICROBALANCE STUDIES: SOLVENT EFFECTS IN CONDUCTING POLYMER FILMS Technical Report, 1 Jan. 1989 - 25 Jan. 1990**
Mary M. Lien, Katsuhiko Naoi, and William H. Smyrl 25 Jan. 1990 4 p
(Contract N00014-88-K-0360)
(AD-A219426; TR-22-ONR) Avail: NTIS HC A01/MF A01 CSCL 07/6

The stoichiometry and mechanism of the intercalation of incorporation of: (1) solvent, and (2) counterion during oxidation/reduction of electroactive polymer films can be established for some systems by the use of QCM techniques. Counterion motion may be predicted from coulometric charge data, and differences between these values and the actual mass change measured by QCM are accounted for, in simple cases, by solvent motion. Evaluation of electrolyte incorporation during break-in of the films were also possible. GRA

**N90-23503#** BioPhotonics, Inc., Greenfield, WI.
**BIOLUMINESCENCE FOR DETECTION OF TRACE COMPOUNDS Final Report, 1 Sep. 1989 - 28 Feb. 1990**
Reinhardt A. Rosson 8 Mar. 1990 32 p
(Contract N00014-89-C-0251)
(AD-A219435) Avail: NTIS HC A03/MF A01 CSCL 06/1

Results of the Phase 1 investigation include: (1) development of a near market-ready biosensor carcinogen detection system for use as a general screening test; (2) detection of ethidium bromide in the 1 ug/ml (1 ppm) range with a yet-to-be optimized genetically cloned sensor; (3) lyophilization and very successful rehydration of cloned biosensors after 1.5 months of storage; (4) early progress in the development of a mercury sensor, which establishes a methodology for the development of a variety of specific biosensors; and (5) development of several light detection systems that include two photodiode based systems, two battery-powered photomultiplier system, and two film techniques. GRA

**N90-23504#** Guelph Univ. (Ontario). Dept. of Chemistry.
**MODES OF ATTACHMENT OF PYRIDINE TO GOLD SURFACES Technical Report No. 11, Aug. 1988 - Mar. 1990**
L. Stolberg, S. Morin, J. Lipkowski, and Donald E. Irish 8 Mar. 1990 5 p
(Contract N00014-87-J-1118)
(AD-A219519) Avail: NTIS HC A01/MF A01 CSCL 07/3

The adsorption of pyridine onto both polycrystalline and single crystal gold electrode surfaces was investigated using three electrochemical techniques: cyclic voltammetry, differential capacity and chronocoulometry. The surface concentration of pyridine, the Gibbs energy of adsorption, the electrosorption valency and the orientation of the pyridine molecules on the gold electrode surfaces, were measured. All of these parameters were found to be sensitive to the structure of the gold electrode surface. GRA

**N90-23505#** Guelph Univ. (Ontario). Dept. of Chemistry.
**AN EXAMINATION OF THE RELATIONSHIP BETWEEN SERS INTENSITIES AND SURFACE CONCENTRATION FOR PYRIDINE ADSORBED AT THE GOLD/AQUEOUS SOLUTION INTERFACE Technical Report No. 14, Aug. 1988 - Mar. 1990**
L. Stolberg, J. Lipkowski, and Donald E. Irish 8 Mar. 1990 5 p
(Contract N00014-87-J-1118)
(AD-A219520) Avail: NTIS HC A01/MF A01 CSCL 07/4

Understanding the relationship between surface enhanced Raman scattering and surface concentrations of molecules is essential to gaining an understanding of the mechanism of SERS. At the metal/solution interface very few such studies have been reported. SERS data is presented for pyridine adsorbed at the polycrystalline gold/aqueous solution interface, for which data for surface coverage is also presented. SERS data for both smooth and rough electrode surfaces are presented. Chronocoulometry was used to obtain reliable surface concentration data for pyridine adsorbed at the polycrystalline gold/aqueous solution interface. SERS data for both smooth and rough electrode surfaces were also collected. Raman intensities of the 1010/cm band of pyridine, measured for various bulk pyridine concentrations, track the surface concentration data very well for surface concentrations less than 3.2 x 10 (exp -10) mol sq cm. The SERS data for roughened gold electrode surfaces do not correspond well to the surface concentration data. SERS generates strong signals at cathodic potentials for which the surface concentrations are small on smooth gold electrodes. GRA

**N90-23506#** Guelph Univ. (Ontario). Dept. of Chemistry.
**ESTIMATION OF THE CONCENTRATION-DISTANCE PROFILE WITHIN THE ELECTROCHEMICAL DIFFUSION LAYER BY RAMAN MICROPROBE SPECTROSCOPY Technical Report No. 12, Aug. 1988 - Mar. 1990**
Toru Ozeki and Donald E. Irish 8 Mar. 1990 13 p
(Contract N00014-87-J-1118)
(AD-A219521) Avail: NTIS HC A03/MF A01 CSCL 07/4

Knowledge of the concentration-distance profile in the region of space extending between an electrode surface and the bulk of the solution is essential for the understanding of electrode processes. Properties within the diffusion layer, stretching from the inner layer to the bulk of the solution, differ from those of the bulk. The concentration gradient in the diffusion layer was measured by Raman microprobe spectroscopy. This method has the advantage that it is molecular specific i.e., the Raman spectrum is unique to the species being detected. The ferricyanide ferrocyanide couple is used as an illustration. Major concentration depletion and accumulation was found in the volume extending from the surface of a gold electrode to 0.2 mm. GRA

**N90-23507#** Massachusetts Inst. of Tech., Cambridge. Dept. of Mechanical Engineering.
**NUMERICAL SIMULATION OF TURBULENT COMBUSTION USING VORTEX METHODS Final Report, 1986 - 1989**
Ahmed F. Ghoniem 8 Jan. 1990 81 p
(Grant AF-AFOSR-0356-84; AF Proj. 2308)
(AD-A219624; AFOSR-90-0283TR) Avail: NTIS HC A05/MF A01 CSCL 20/4

A new numerical method was developed for the integration of the unaveraged, time dependent, high Reynolds number Navier-Stokes equations governing a reacting flow. This method, which is called the transport element, is a grid free Langrangian field method which was developed for the simulation of reacting flow, and to describe mechanisms of shear flow-combustion interaction which were revealed using these methods. GRA

**N90-23508#** Naval Postgraduate School, Monterey, CA. Dept. of Electrical and Computer Engineering.
**IMPLEMENTATION OF IMAGE ACTION PLUS SOFTWARE FOR IMAGE ANALYSIS OF SOLID PROPELLANT COMBUSTION HOLOGRAMS M.S. Thesis**
Valerie Ruth Hockgraver Sep. 1989 91 p Sponsored by Air Force Astronautics Lab., Edwards AFB, CA
(AD-A219644) Avail: NTIS HC A05/MF A01 CSCL 12/5

This thesis supports computer-aided data analysis of holograms produced from rocket motor firings. The work modified existing software code to make it compatible with installed upgrades in the microcomputer imaging system. In particular this involved converting the format of C language function calls to ITEX/PC image processing software to that dictated by ITEX/PC plus software. Additional modifications were performed to enhance code portability and optimization. Results indicate that all efforts to incorporate the new system software have been successful. GRA

**N90-23509#** Columbia Univ., New York, NY. Dept. of Chemistry.
**COMBINED EFFECT OF ISOTOPIC SUBSTITUTION, TEMPERATURE, AND MAGNETIC FIELD ON THE LIFETIMES OF TRIPLET BIRADICALS Scientific Report, 1988 - 1989**
Jin-Feng Wang, V. Pushkara Rao, Charles Doubleday, Jr., and Nicholas J. Turro 1990 4 p Repr. from Journal of Physical Chemistry, v. 94, 1990 p 1144-1146 Sponsored in part by DOE

(Grants AF-AFOSR-0049-90; NSF CHE-87-22164; AF Proj. 2303)
(AD-A219711; AFOSR-90-0321TR) Avail: NTIS HC A01/MF A01 CSCL 07/4

Lifetimes tau for decay of triplet biradicals derived from 2-pheylcycloalkanones were measured by nanosecond transient absorption under conditions designed to probe the contribution of intersystem crossing and chain dynamics to the observed decay. The temperature dependence of tau was measured at both 0 and 2kG magnetic field, and also in the presence of 0.004 M manganous chloride. Under a variety of conditions of temperature, solvent viscosity, and magnetic field, the lifetime of the biradical derived from 2-phenylcyclododecanone was compared with its perdeuterated analogue and with a 1:1 mixture of 1,2-(13)C2 and 1,12-(13)C2 isotopomers. The magnetic isotope effect on tau and the temperature dependence of Mn(2+) quenching support chain dynamics as the rate-limiting step at room temperature. However, the magnetic field effect on tau reaches a maximum around -50 C and persists even at -99 C, in contrast to the magnetic isotope effect and Mn(2+) quenching which are absent at low temperature. GRA

**N90-23510#** University of Southern California, Los Angeles. Dept. of Chemistry.
**THE 18TH INFORMAL CONFERENCE ON PHOTOCHEMISTRY Final Report, 1 Sep. 1988 - 30 Aug. 1989**
Curt Wittig and Hanna Reisler 15 Feb. 1990 23 p Conference held in Santa Monica, CA, 9-13 Jan. 1989
(Grant AF-AFOSR-0289-88; AF Proj. 2303)
(AD-A219779; AFOSR-90-0331TR) Avail: NTIS HC A03/MF A01 CSCL 07/5

Photodissociation dynamic topics addressed include: vibrationally excited radicals; photodissociation dynamics; multiphoton dissociation and modeling; decay kinetics; electronic excitation transfer; high energy photophysics and photochemistry; photoionization spectroscopy; reactivity of aniline cations; vibrational spectroscopy; photofragment spectroscopy; UV spectroscopy; molecular beam studies; time resolved emission spectroscopy; laser induced fluorescence; and excimer laser photochemistry. GRA

**N90-23511#** Wright Research Development Center, Wright-Patterson AFB, OH. Power Components Branch.
**REACTIONS OF SILANE IN ACTIVE NITROGEN Ph.D. Thesis - Oklahoma Univ. Final Report, Sep. 1984 - Jan. 1990**
Charles A. DeJoseph, Jr. 29 Jan. 1990 125 p
(AF Proj. 2301)
(AD-A220371; WRDC-TR-90-2001) Avail: NTIS HC A06/MF A01 CSCL 07/2

Silane is used in the production of amorphous silicon and thin films of silicon nitride. In the production of the latter, silane is mixed with either ammonia or nitrogen in a low pressure electric discharge, and a thin film of silicon nitride is formed at the boundaries of the discharge. Besides the chemical reactions which are driven directly by electrons in the discharge, a number of reactions are believed to occur among chemically reactive, neutral species. These reactions can have a significant effect on the silane dissociation which occurs in these discharges. To study this neutral chemistry, an experimental program along with a coupled rate equation modeling effort was undertaken of the reactions of silane in discharge-produced active nitrogen. Measurements of silane dissociation produced by active nitrogen, spectra of the chemiluminescence produced in the reaction, and a rate equation model developed to describe the results are presented. GRA

**N90-23512#** Stevens Inst. of Tech., Hoboken, NJ. Plasma and Surface Physics Lab.
**SURFACE PHYSICS INSTRUMENTATION Final Report, 1 Dec. 1988 - 30 Nov. 1989**
Milos Seidl, Joshua Isenberg, Seong I. Kim, and Andrew E. Souzis 29 Jan. 1990 25 p
(Grant AF-AFOSR-0195-89; AF Proj. 3842)
(AD-A220460; AFOSR-90-0340TR) Avail: NTIS HC A03/MF A01 CSCL 20/12

This report describes the considerable improvements in surface physics instrumentation at the Plasma and Surface Physics Laboratory made possible grant. The following three add-on instruments were purchased: Scanning Tunneling Microscope (STM), Low Energy Electron Diffractometer (LEED), and Quadrupole Mass Spectrometer (QMS). A unique design has been chosen for STM. Starting with a non-vacuum STM (Nanoscope II), a vacuum compatible STM head was designed. The head uses the Nanoscope computer and can be attached to either of our UHV chambers. All the acquired instruments have been integrated with the two surface instrumentation systems existing in the laboratory. The Surface Analysis System is equipped with Auger Electron Spectroscopy (AES), Ultra Violet Photoelectron Spectroscopy (UPS), Work Function Measuring Station and Sample Transfer System for the STM. The Ion Beam System is equipped with the Quadrupole Mass Spectrometer Ion Mass Spectroscopy used for Spectroscopy, LEED, two Ion Beam Lines and Sample Transfer System for the STM. GRA

**N90-23513#** Swedish Inst. of Space Physics, Kiruna.
**AN INTENSITY EXPRESSION ORGANISING SPECTRAL LINE INTENSITY DATA**
Bo Thelin Nov. 1989 15 p
(IRF-SR-202; ISSN-0284-1703; ETN-90-96577) Avail: NTIS HC A03/MF A01

A new spectral line intensity expression for describing spectral data is discussed. Linear graphs were obtained when studying the logarithm of given spectral line intensity proportionality. These results were obtained from the UV to the IR spectral regions, using standard tables or spectral line intensitites from dc arc experiments. Similar results were obtained when an Inductively Coupled Plasma (ICP) was used in combination with a photon counting IDES spectrometer system. With another method spectral line intensity ratio fluctuations are studied with an ICP-IDES system. Support of the exp term obtained in logarithm was found. A linear graph was obtained when spectral line intensity ratio fluctuations were plotted against the differences in photon energies for the spectral transitions. Thus two independent methods give support to the new expression for spectral line intensity over a wide spectral range in various experiments. ESA

**N90-23514#** Denver Univ., CO.
**INFORMAL CONFERENCE ON THE CHEMISTRY OF ENERGETIC AZIDES, ISOCYANATES, AND RELATED SPECIES Final Report, period ending 1 Nov. 1988**
Robert D. Coombe 16 Feb. 1990 44 p Conference held in Denver, CO, 27-28 Apr. 1988
(Grant AF-AFOSR-0291-88)
(AD-A219825; AFOSR-90-0348TR) Avail: NTIS HC A03/MF A01 CSCL 05/2

Topics addressed include: dissociation dynamics, spectroscopy and theory, and reactions of energetic azides and isocyanates. GRA

**N90-23515#** Pennsylvania State Univ., University Park.
**PREMIXED TURBULENT FLAME PROPAGATION Final Report, 1 Nov. 1986 - 31 Oct. 1989**
Domenic A. Santavicca 12 Feb. 1990 15 p
(Grant AF-AFOSR-0097-87; AF Proj. 2308)
(AD-A219834; AFOSR-90-0352TR) Avail: NTIS HC A03/MF A01 CSCL 21/2

The results of an experimental study of turbulence-flame interactions and their effect on turbulent flame propagation are reported. Experiments are conducted in a new turbulent flow system which is capable of producing relative turbulence intensities as high as 100 percent. Using a freely propagating, one-dimensional flame configuration, measurements are made using LDV of the mean velocity, turbulence intensity, integral time scale, energy spectrum, Reynolds stress, and integral length scale, at a fixed location both before and after flame arrival. A complete set of such measurements was made at one operating condition which characterize both the magnitude of flame generated turbulence and its anisotropic nature. The freely propagating, one dimensional

flame configuration was also used to study the effect of turbulence on turbulent flame structure. Two dimensional Mie scattering is used to obtain a two-dimensional slice of the turbulent flame surface. Such measurements were made at 15 different conditions over very broad range of turbulence Reynolds and Damkohler numbers and were analyzed to determine the fractal nature of the turbulent flame surface. The results of these measurements show that premixed turbulent flame surfaces are fractal throughout the reaction sheet regime. GRA

**N90-23516#** Chemical Research and Development Center, Aberdeen Proving Ground, MD.
**APPLICATION OF NOVEL DATA PROCESSING TECHNIQUES TO THE ANALYSIS OF ION MOBILITY SPECTROMETRY (IMS) DATA Technical Report, Feb. - May 1988**
Dennis Davis and Robert T. Kroutil Jan. 1990 26 p
(DA Proj. 1C1-62622-A-553)
(AD-A219976; CRDEC-TR-138) Avail: NTIS HC A03/MF A01 CSCL 20/5

Over the past several years, novel data processing techniques have been developed for infrared spectroscopy. Many of these techniques use digital filters in the time domain to isolate spectral features. These features have use in other areas of spectral data processing. One of these areas is in the analysis of Ion Mobility Spectrometry (IMS) data. This work describes the preliminary investigation into this application. GRA

**N90-23517*** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**CATALYST FOR CARBON MONOXIDE OXIDATION Patent**
Billy T. Upchurch, inventor (to NASA), Irvin M. Miller, inventor (to NASA), David R. Brown, inventor (to NASA), Patricia P. Davis, inventor (to NASA), David R. Schryer, inventor (to NASA), Kenneth G. Brown, inventor (to NASA), and John D. VanNorman, inventor (to NASA) (Old Dominion Univ., Norfolk, VA.) 27 Mar. 1990 5 p Filed 18 Jan. 1989 Supersedes N90-11823 (28 - 3, p 321)
(NASA-Case-LAR-14155-1-SB; US-Patent-4,912,082; US-Patent-Appl-SN-298150; US-Patent-Class-502-218; US-Patent-Class-502-217; US-Patent-Class-502-226; US-Patent-Class-502-239; US-Patent-Class-502-241; US-Patent-Class-502-245; US-Patent-Class-502-324) Avail: US Patent and Trademark Office CSCL 07D

A catalyst is disclosed for the combination of CO and O2 to form CO2, which includes a platinum group metal (e.g., platinum); a reducable metal oxide having multiple valence states (e.g., SnO2); and a compound which can bind water to its structure (e.g., silica gel). This catalyst is ideally suited for application to high-powered pulsed, CO2 lasers operating in a sealed or closed-cycle condition.
Official Gazette of the U.S. Patent and Trademark Office

**N90-23518*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**FUEL-RICH CATALYTIC COMBUSTION: A FUEL PROCESSOR FOR HIGH-SPEED PROPULSION**
Theodore A. Brabbs (Sverdrup Technology, Inc., Brookpark, OH.), R. James Rollbuhler, and Erwin A. Lezberg 1990 11 p Presented at the 26th Joint Propulsion Conference, Orlando, FL, 16-18 Jul. 1990; cosponsored by AIAA, SAE, ASME, and ASEE
(NASA-TM-103177; E-5555; NAS 1.15:103177; AIAA-90-2319) Avail: NTIS HC A03/MF A01 CSCL 21B

Fuel-rich catalytic combustion of Jet-A fuel was studied over the equivalence ratio range 4.7 to 7.8, which yielded combustion temperatures of 1250 to 1060 K. The process was soot-free and the gaseous products were similar to those obtained in the iso-octane study. A carbon atom balance across the catalyst bed calculated for the gaseous products accounted for about 70 to 90 percent of the fuel carbon; the balance was condensed as a liquid in the cold trap. It was shown that 52 to 77 percent of the fuel carbon was C1, C2, and C3 molecules. The viability of using fuel-rich catalytic combustion as a technique for preheating a practical fuel to very high temperatures was demonstrated. Preliminary results from the scaled up version of the catalytic combustor produced a high-temperature fuel containing large amounts of hydrogen and carbon monoxide. The balance of the fuel was completely vaporized and in various stages of pyrolysis and oxidation. Visual observations indicate that there was no soot present. Author

**N90-23519#** Ecole Centrale de Lyon (France).
**CONTRIBUTIONS TO THE STUDY OF PARIETAL FLAMES DUE TO TURBULENT DIFFUSION Ph.D. Thesis [CONTRIBUTIONS A L'ETUDE DES FLAMMES PARIETALES TURBULENTES DE DIFFUSION]**
Bui-Van Ga 1989 226 p In FRENCH
(ECL-89-22; ETN-90-96938) Avail: NTIS HC A11/MF A02

Thermal transfer between flame and container wall is investigated. The theoretical and experimental conditions are those found in combustion inside a diesel engine. A series of fundamental equations governing the axisymmetric turbulent flame are presented. These take into account the variations in the physical properties of the fluid. The role of temperature, especially the effects due to variations in the volumetric mass, are descibed. The Deissler equation based on the Van Karman model is shown to be effective in flame analysis. ESA

**N90-23520#** Ecole Centrale de Lyon (France).
**THE DIELECTRIC BEHAVIOR OF SULFUR HEXAFLUORIDE SUBMITTED TO RAPID TRANSITORY OVERVOLTAGES Ph.D. Thesis [ETUDE DU COMPORTEMENT DIELECTRIQUE DE L'HEXAFLUORURE DE SOUFRE SOUS SURTENSIONS TRANSITOIRES RAPIDES]**
Zong Yin Ren 1989 147 p In FRENCH
(ECL-89-16; ETN-90-96941) Avail: NTIS HC A07/MF A01

The discharge mechanisms of sulfur hexafluoride are studied. The dielectric properties of sulfur hexafluoride (SF6) are reviewed. Tests are carried out during which the SF6 is submitted to rapid transitory voltages up to 1300 kV at a frequency of 700 kHz. Voltages of 1100 kV with a frequency of 13 MHz are used in another series of tests. The voltage generator and the automated measuring devices used in the testing are described in detail. The test results are presented. They show that rapid transitory overvoltages do no more harm than lightning strikes on the SF6 electrodes studied. The use of SF6 electrodes in circuit breakers is discussed. ESA

**N90-23521#** Ecole Centrale de Lyon (France). Lab. de Technologie des Surfaces.
**AN ANALYTICAL STUDY OF TRIBOCHEMICAL PHASES WITH COLLOIDAL ADDITIVES. CONTRIBUTIONS MADE BY ENERGY FILTERING ELECTRON MICROSCOPY Ph.D. Thesis [ETUDE ANALYTIQUE DES PHASES TRIBIOCHIMIQUES AVEC DES ADDITIFS COLLOIDAUX. APPORT DE LA MICROSCOPIE FILTREE EN ENERGIE]**
Martine Hallouis 1989 112 p In FRENCH Original contains color illustrations
(ECL-89-009; ETN-90-96943) Avail: NTIS HC A06/MF A01

Energy filtering electron microscopy techniques are used to determine the nature of the final products of the tribochemical reactions involving zinc dithiophosphate. The crystalline phase dispersed in the interfacial film is given particular attention. Quantification of this phase is carried out. Based on the results of the microscopic analysis of the crystalline phase, a tribochemical reaction model for the reaction of zinc dithiophosphate with iron-containing materials is proposed. The wear reducing role that zinc dithiophosphate plays as an additive to lubricants is discussed. ESA

# 26 METALLIC MATERIALS

Includes physical, chemical, and mechanical properties of metals, e.g., corrosion; and metallurgy.

**N90-23522#** United Kingdom Atomic Energy Authority, Harwell (England). National Nondestructive Testing Centre.
**CHARACTERISATION OF FATIGUE OF ALUMINIUM ALLOYS BY ACOUSTIC EMISSION. PART 1: IDENTIFICATION OF SOURCE MECHANISM**
D. J. Buttle and C. B. Scruby Sep. 1988 36 p
(AERE-R-13302-Pt-1) Avail: NTIS HC A03/MF A01

Two series of acoustic emission (AE) measurements were carried out on 7000 series aluminum alloys. The first series investigated the material processes responsible for primary AE during fatigue of compact tension specimens, while the objective of the second series of experiments (Part 2, Buttle and Scruby, 1989) was to distinguish between different emission sources during high cycle fatigue of riveted test coupons. The conclusion of the first series of experiments was that each primary emission event was associated with the sudden growth of a microcrack from the fatigue crack tip to a fractured inclusion just ahead of the crack front. This conclusion was reached by analyzing the three dimensional locations of each emission event using extremely accurate transducer and advanced signal processing. The errors in location were 100 micrometers, which enabled the events to be located within + or - 90 micrometers of the plane of the crack front. This refuted a previous model in which the emission was generated by the fracture of inclusions as the whole plastic zone (0.8 mm diameter) moved through the alloy. The data demonstrate how this accurate AE technique can be used to plot very precisely the shape and position of the crack front at any stage of the fatigue, and also show the extent of defect growth over a given number of cycles. Author

**N90-23523#** United Kingdom Atomic Energy Authority, Harwell (England). National Nondestructive Testing Centre.
**CHARACTERISATION OF FATIGUE OF ALUMINIUM ALLOYS BY ACOUSTIC EMISSION. PART 2: DISCRIMINATION BETWEEN PRIMARY AND OTHER EMISSIONS**
D. J. Buttle and C. B. Scruby Sep. 1988 47 p
(AERE-R-13303-Pt-2) Avail: NTIS HC A03/MF A01

Two series of acoustic emission (AE) measurements were carried out on 7000 series aluminum alloys. The first series (Part 1, Buttle and Scruby, 1989) investigated the material processes responsible for primary AE during fatigue of compact tension specimens, while the objective of the second series of experiments was to distinguish between different emission sources during high cycle fatigue of riveted test coupons. In the second series of experiments primary (crack growth), secondary (fretting of the rivet), and spurious emission events were all detected. These three sources of AE were characterized using 6 parameters: time dependency/frequency content; relationship to applied cyclic load; principal wave arrival amplitude; reproducibility; location; and radiation pattern. These results are relevant for airframe monitoring as they offer specific criteria for distinguishing primary from other emissions. However, all except the applied cyclic load and principal wave arrival amplitude require sensors and recording systems of high fidelity and bandwidth. As at least two criteria need to be met for reliable identification, dependable discrimination is only possible if special broadband instrumentation is used. Author

**N90-23524#** Oak Ridge National Lab., TN.
**VANADIUM ALLOYS WITH IMPROVED RESISTANCE TO HELIUM EMBRITTLEMENT**
David N. Braski 1990 34 p Presented at the 15th Symposium on Effects of Radiation on Materials, Nashville, TN, 17-21 Jun. 1990
(Contract DE-AC05-84OR-21400)
(DE90-009811; CONF-900623-3) Avail: NTIS HC A03/MF A01

A series of experimental vanadium alloys were designed with small MC-type carbides in their microstructures to trap helium produced during neutron irradiation, thereby reducing helium embrittlement. The tensile properties and fabricability of the alloys were strongly influenced by the amounts of MC-forming-elements, especially carbon. Alloys with 0.05 and 0.10 wt percent carbon exhibited slightly lower yield strengths at 420 to 600 C than vanadium alloys such as V-5Cr-5Ti, Vanstar-7, V-3Ti-1Si, and V-15Cr-5Ti. However, this characteristic may actually be an asset from the standpoint of resistance to irradiation hardening. After implantation with 300 appm He-3, both the V-Ti-C and V-Ti-Zr-C alloys exhibited less ductility losses at 600 C than the other vanadium alloys tested under comparable conditions. Examination of the experimental alloy microstructures by AEM showed that the small MC-type carbides did, in fact, trap helium and that they were responsible for the increased resistance to helium embrittlement of these alloys. DOE

**N90-23525#** Minnesota Univ., Minneapolis. Corrosion Research Center.
**MODELING AND EXPERIMENTAL STUDIES OF OXIDE COVERED METAL SURFACES Progress Report**
William H. Smyrl, J. Woods Halley, Richard A. Oriani, Henry S. White, Michael F. Toney, and Owen R. Melroy (IBM Research Lab., San Jose, CA.) 1990 34 p
(Contract DE-FG02-88ER-45338)
(DE90-009961; DOE/ER-45338/T2) Avail: NTIS HC A03/MF A01

The collaborative research effort of the Aqueous Group of the Corrosion Research Center has focussed on the physical, chemical, and electronic structure of native and anodically grown TiO2 films. The stability of Ti in corrosive environments is due entirely to the presence of the oxide film; thus, our goal is to correlate measurable structural parameters of the oxide film with the corrosion resistance that it imparts to the base metal. The fundamental nature of both theoretical and experimental approaches taken in studying TiO2 films will allow key factors underlying oxide film stability to be identified and translated to other materials. DOE

**N90-23526#** Clarkson Univ., Potsdam, NY. Dept. of Chemical Engineering.
**UNDERCOOLING AND NUCLEATION IN RAPID SOLIDIFICATION RATE METAL POWDERS USING SOLID IN SOLID EMULSIFICATION Final Report, 1 Aug. 1985 - 31 Dec. 1988**
Donald Rasmussen 8 Nov. 1989 19 p
(Contract DAAG29-85-K-0196)
(AD-A218527; ARO-22779.3-MS) Avail: NTIS HC A03/MF A01 CSCL 13/8

Fine particulates, with dimensions of 10 microns or less, offer an opportunity to study phase transitions between the liquid and solid states as well as means to obtain material properties for undercooled liquids not obtainable in bulk samples. These advantages are exploited in both metal powder and ceramic powder processing technology. In fact, metal powders find many applications where homogeneous structures are beneficial. Such homogeneous structures being obtained by segregationless solidification at high undercooling. Representative applications for controlled narrow size distribution metal powders include superalloys, superplastic aluminum alloys, composite materials, magnetic recording media, ferrofluids and conducting plastics. Developments in rapid solidification processing (RSP) have enabled superalloy powders to be used for high temperature and pressure applications. RSP metal and alloy powders are typically produced through atomization from-the-melt processes. GRA

**N90-23527#** European Research Office, London (England).
**PRELIMINARY INVESTIGATION INTO THE EFFECT OF HIGH TEMPERATURE THERMAL ANNEALS ON THE FIGURE OF MERIT OF SILICON GERMANIUM ALLOYS Final Technical Report**
D. M. Rowe Jan. 1990 26 p Prepared in cooperation with University Coll., Carrdiff, Wales
(Contract DAJA45-88-M-0424)
(AD-A218573; R/D-6106-PH-01) Avail: NTIS HC A03/MF A01 CSCL 20/3

In this report is embodied the results of a preliminary theoretical

and experimental investigation into the effect of high temperature thermal anneals on the thermoelectric figure of merit of silicon germanium-gallium phosphide material. A realistic theoretical model for the silicon germanium alloy system is employed to investigate the effect of an increase in the doping level on the electrical power factor alpha square (sigma) where alpha is the Seebeck coefficient and sigma the electrical conductivity. The assumption is made that the addition of gallium phosphide to silicon germanium alloy serves only to increase the dopant solubility and hence the carrier concentration. The theoretical analysis indicates that the reported factor of 1.6 increase in the carrier concentration of heat treated silicon germanium-gallium phosphide material compared to conventional silicon germanium alloy would result in an increase in the electrical power factor of between 12 to 14 percent at room temperature rising to 18 to 22 percent at 1000 K. The results of this program of work support the conclusion that the electrical power factor and hence the figure of merit of silicon germanium-gallium phosphide can be significantly improved by high temperature thermal anneals. GRA

**N90-23528#** Stanford Univ., CA. Electronics Lab.
**FUNDAMENTAL AND PRACTICAL STUDIES OF METAL CONTACTS ON MERCURY ZINC TELLURIDE Final Technical Report, 1 Sep. 1986 - 31 Aug. 1989**
W. E. Spicer, I. Lindau, and A. K. Wahi 31 Aug. 1989 29 p
(Contract N00014-86-K-0854; ARPA Order 5674)
(AD-A218730) Avail: NTIS HC A03/MF A01 CSCL 07/4

How the metal overlayer grows and chemically interacts with the substrate in metal/II-VI systems such as cadmium telluride and zinc telluride has practical importance for the electrical characteristics of metal contacts to these materials. By studying metal interfaces with these binaries, insight is gained into the role of the weak mercury-bonding in the alloys mercury cadmium telluride and mercury zinc telluride during metal contact formation, where severe Hg depletion on the order of 20 to 60 percent from the top few layers of the HgCdTe substrate is typically observed upon metal deposition. We report results of our comparative study of the interfacial chemistry and band bending behavior for aluminum, indium, silver, and platinum overlayers on vacuum-cleaved (p)-CdTe and (p)-ZnTe(110) using both UPS and XPS. A range of metal-substrate reactivities were considered: Al reacts strongly with tellurium, Ag moderately, and In minimally, with no evidence seen for In reaction on ZnTe. Pt exhibits strong alloying behavior with both Cd and Zn. These results are compared for the binaries to metal/HgCdTe interface formation. It was found that Hg loss can significantly influence the extent of reaction and/or intermixing for these overlayers, with resulting disruption either inhibiting or facilitating chemical interaction. Band bending is considered at these metal/CdTe and metal/ZnTe interfaces to correlate Fermi level movement in the bandgap during metal deposition with interfacial chemistry and morphology. GRA

**N90-23529#** Wisconsin Univ., Madison.
**SOLIDIFICATION OF HIGHLY UNDERCOOLED LIQUID DROPLETS Final Report, 1 Jul. 1986 - 30 Jun. 1989**
J. H. Perepezko Jan. 1990 75 p
(Contract DAAL03-86-K-0114)
(AD-A218776; ARO-23617.13-MS) Avail: NTIS HC A04/MF A01 CSCL 11/6

Research was focused upon metastable phase formation and the controlling phase selection reactions, the evolution of solidification microstructure under the combined influence of undercooling, recalescence and external cooling and several other aspects of undercooled alloy solidification and product structure stability. The experimental approach that was applied to carry out these studies is based on the droplet emulsion technique. With this method, samples may be produced which exhibit large undercoolings prior to solidification during slow cooling (10 to 30 deg C/min) and which may be maintained in the metastable undercooled state for extended time periods without the intervention of crystallization. GRA

**N90-23530#** Stanford Univ., CA. Dept. of Materials Science and Engineering.
**ULTRAHIGH CARBON STEELS AND THEIR LAMINATES Final Report, Aug. 1984 - Nov. 1989**
Oleg D. Sherby 1 Feb. 1990 6 p
(Contract DAAG29-84-K-0190)
(AD-A218780; ARO-22286.1-MS) Avail: NTIS HC A02/MF A01 CSCL 11/6

It is proposed that major development efforts on ultrahigh carbon steels (UHCS) and their laminates are timely and programs to evaluate prototype structural components should be initiated. The hardenability of fine grained UHC steel is improved by dilute alloying additions of manganese, aluminum and nickel. The impact resistance of UHCS laminated composites, after selective heat treatment, can be enhanced by appropriate choice of interleaf material. Two factors are important: the interlayer boundary should be discrete and the interleaf material should be notch ductile. Several interleaf materials were investigated including Fe-3Si, Hadfield manganese steel, 304 stainless steel, Fe-9Ni-2Si, and brass. GRA

**N90-23531#** Westinghouse Electric Corp., Pittsburgh, PA. Advanced Energy Systems Div.
**INVESTIGATION OF METAL PROCESSING TECHNOLOGY Final Report, 1 Oct. 1985 - 28 Apr. 1989**
Ivan A. Martorell, Tom E. Jones, Joe O. Brown, P. M. French, and Vinod Jain 26 Oct. 1989 217 p
(Contract F33615-85-C-5035)
(AD-A218835; WRDC-TR-89-4098) Avail: NTIS HC A10/MF A01 CSCL 11/6

The research conducted on metal processing over the 42-month period from October 1985 to April 1989 is summarized. The research includes work on hot isothermal compression testing, lubrication data on ring compression tests, designing and building of high temperature environment chamber for the forge press, designing and building backup tooling for the extrusion press, programming a data acquisition and management system for the extrusion press and reaching the milestone of the facilities 10,000th extrusion. Information derived from this and previous research was applied to the processing of over 3000 billets, bars and melting of numerous alloys. Extrusion data for billets processed under this contract are shown. GRA

**N90-23532#** Martin Marietta Labs., Baltimore, MD.
**A STUDY OF THE INFLUENCE OF ALLOYING ADDITIONS ON THE PASSIVITY OF ALUMINIUM Annual Report, 1 Dec. 1988 - 30 Nov. 1989**
B. A. Shaw, G. D. Davis, T. L. Fritz, and W. C. Moshier (Martin Marietta Space Systems, Inc., Denver, CO.) Feb. 1990 36 p
(Contract N00014-85-C-0638)
(AD-A219630; MML-TR-90-28C) Avail: NTIS HC A03/MF A01 CSCL 11/6

The susceptibility of aluminum and aluminum alloys to pitting in aqueous chloride-containing environments is well known. Typical aluminum alloying constituents such as copper, silicon, zinc, and magnesium are added to improve mechanical properties, and not to provide corrosion resistance. Passivity enhancing species, such as Cr, Mo, Ta and W, typically exhibit very low solubility limits in aluminum, well below 1 at. percent and at these concentrations exert little influence on corrosion behavior. The solubility limits for these elements in aluminum can be exceeded and corrosion performance enhanced if the alloys are produced using a rapid solidification method such as vapor deposition. In this fourth year of the program the corrosion resistance of three binary alloys Al-V, Al-Nb, and Al-W and one physically vapor deposited ternary alloy are evaluated. The Al-W alloys exhibit the best localized corrosion resistance observed to date with increases in Ep up to 2600 mV with the addition of 10.3 at. percent W to Al. Additionally, the corrosion performance of Al-8 at. percent W specimens that were heat treated to produce a two-phase alloy are comparable to those found earlier for single-phase Al-8 at. percent Mo alloys. Characterization of the physically vapor deposited ternary alloy reveals that several atomic percent of passivity enhancing species

can be retained in solid solution with this process and therefore this technique is very promising for the production of nonequilibrium corrosion-resistance aluminum alloys. GRA

**N90-23533#** Lehigh Univ., Bethlehem, PA. Center for Surface Studies.
**CORROSION CONTROL THROUGH A BETTER UNDERSTANDING OF THE METALLIC SUBSTRATE/ORGANIC COATING INTERFACE Annual Report, 1 Oct. 1988 - 30 Sep. 1989**
Henry Leidheiser, Jr. and Richard D. Granata 16 Mar. 1990 55 p
(Contract N00014-89-J-1089)
(AD-A220432) Avail: NTIS HC A04/MF A01 CSCL 11/3

The research included the following subject areas: application of positron annihilation spectroscopy to coatings; appraisal of coatings using electrochemical impedance spectroscopy as a function of temperature; and the mechanism of corrosion inhibition by lead pigments in coatings. GRA

**N90-23534#** Wright Research Development Center, Wright-Patterson AFB, OH. Materials Behavior Branch.
**THE EFFECTS OF SLIP CHARACTER AND CRACK CLOSURE ON THE GROWTH OF SMALL FATIGUE CRACKS IN TITANIUM-ALUMINIUM ALLOYS Ph.D. Thesis - Carnegie Mellon Univ. Final Report, Sep. 1982 - Dec. 1987**
James M. Larsen Feb. 1990 280 p
(AF Proj. 2302)
(AD-A220714; WRDC-TR-89-4094) Avail: NTIS HC A13/MF A02 CSCL 11/6

An investigation was performed to study the effects of slip character and crack closure on the propagation of small fatigue cracks in titanium-aluminum alloys. The materials examined were solution-treated Ti-4Al and Ti-8Al, as well as aged Ti-8Al. The propagation of naturally initiated surface cracks of depths as small as 25 micrometers was compared with the behavior of large through-thickness cracks. An extensometer was used to monitor crack closure throughout the large crack tests, and the closure behavior of the small cracks was measured using a computerized laser interferometric displacement gage having a displacement resolution of 0.01 micrometer. The measurements of crack closure were used to compute an effective stress intensity factor range. In all three alloys and for all test conditions, which included a range of stress levels and stress ratios, small cracks propagated faster than large cracks subjected to an equivalent Delta K, and the small cracks propagated under conditions that were significantly below the large-crack threshold, Delta K(th). Although the character and distribution of slip in Ti-Al alloys may have a dramatic influence on fatigue crack initiation and on the propagation of large cracks, this effect was minimal for small cracks. GRA

**N90-23535#** Aerospatiale Aquitaine, Saint-Medard en Jalles (France). Div. Systemes Strategiques et Spatiaux.
**SOLIDIFICATION OF DILUTE ALLOYS UNDER FLUCTUATING RESIDUAL GRAVITY**
Didier Thevenard and Jean-Jacques Favier (Institut de Mecanique des Fluides de Marseille, France ) 25 Jun. 1989 17 p
(Contract ESA-7681/88)
(Rept-892-430-112; ETN-90-96643) Avail: NTIS HC A03/MF A01

Results on the influence of g-jitters on crystal growth in space are presented. The study is restricted to dilute alloys, for which the study of convective flows may be performed independently of the study of dopant concentrations in the liquid phase. Characteristic features of convective flows in a rectangular cavity subject to a longitudinal thermal gradient and to a fluctuating gravity normal to the gradient are presented. Analytical solutions are derived and a brief comparison with numerical results is done. The possible influence of these convective flows on the solute distribution in the liquid during a crystal growth experiment is studied. Interesting non-dimensional parameters and the general behavior of the system are determined with the help of a time-dependent finite elements program. A case study and general conclusions are proposed. ESA

**N90-23536*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**ASSESSMENT OF FUNDAMENTAL MATERIALS NEEDS FOR THICK THERMAL BARRIER COATINGS (TTBC'S) FOR TRUCK DIESEL ENGINES Final Report**
Robert A. Miller May 1990 56 p
(Contract DE-AI05-87OR-21749)
(NASA-TM-103130; E-5460; DOE/NASA/21749-1; NAS 1.15:103130) Avail: NTIS HC A04/MF A01 CSCL 11F

The present state of development of thick thermal barrier coatings for truck diesel engines is assessed and areas where improved fundamental understanding is needed to properly pursue development are identified. Emphasis is given to the coating systems and design approaches that are being developed for the next generation of truck diesel engines under DOE/NASA support. It is noted that, while considerable progress has been made, the current level of understanding of coating system behavior is inadequate and this lack of fundamental understanding may impede current and future development. Several areas where improved understanding would be especially valuable are identified and recommendations for research into those areas are offered. Author

**N90-23537#** Iowa Univ., Iowa City. Dept. of Microbiology.
**ARCHAEBACTERIAL INVOLVEMENT IN MICROBIAL METAL CORROSION: METABOLISM OF S AND Fe Annual Report, 1 Feb. 1989 - 1 Feb. 1990**
Lacy Daniels 19 Mar. 1990 5 p
(Contract N00014-88-K-0195; NR Proj. RR0-416)
(AD-A219982) Avail: NTIS HC A01/MF A01 CSCL 06/13

The objectives were to understand the role that methanogenic bacteria play in metal corrosion. The ability to use Fe, Al, Zn, Co and Ni (to some degree) as electron donors in methanogenesis was demonstrated, which suggests their possible role in biocorrosion; the environmental conditions affecting the rates of metal oxidation were studied further. Key methanogenic enzymes involving in electron consumption (format dehydrogenase, hydrogenase and methylene THMP dehydrogenase) were also studied. The effects of alkyl tins on methanogens was examined, due to the use of one such compound, tributyl tin, in anticorrosion paints as a biocide. It was found that many organotins are more toxic to methanogens than tributyl tin and that the relationship of hydrophobicity of the organotin to toxicity is quite different than observed by others in studies of aerobic organisms. GRA

**N90-23538#** Dayton Univ., OH.
**FATIGUE CRACK GROWTH INVESTIGATION OF A Ti-6Al-4V FORGING UNDER COMPLEX LOADING CONDITIONS: NATO/AGARD SUPPLEMENTAL ENGINE DISK PROGRAM Interim Report, Jun. 1988 - Oct. 1989**
John J. Ruschau and Peter A. Krawczyk (Wright Research Development Center, Wright-Patterson AFB, OH.) Feb. 1990 68 p
(Contract F33615-88-C-5437; AF Proj. 2418)
(AD-A220239; UDR-TR-89-114; WRDC-TR-90-4001) Avail: NTIS HC A04/MF A01 CSCL 11/6

Fatigue crack growth rate testing was performed on a Titanium-6 Aluminum-4 Vanadium engine disk forging as part of the SUPPLEMENTAL Engine Disk Program sponsored by the North Atlantic Treaty Organization's Advisory Group for Aerospace Research and Development (NATO/AGARD). Such data were developed under room temperature conditions under a variety of load histories, ranging from constant amplitude with periodic overload to various forms of the TURBISTAN engine spectrum. The effects of each loading condition are examined with respect to fatigue crack growth rates. Crack growth mechanisms are identified for the various load histories based on SEM examinations. Comparisons are made between crack growth rates determined via electric potential methodology and those from fatigue striation measurements. GRA

**N90-23539#** Helsinki Univ. of Technology, Espoo (Finland). Lab. of Metal Working and Heat Treatment.
**CROWN AND SHAPE CONTROL IN THE ROLLING OF THIN, WIDE PLATES Ph.D. Thesis**
P. T. Mayentylae 1989 91 p Sponsored by Rautaruukki
(ETN-90-96946) Avail: NTIS HC A05/MF A01

Developments in the rolling process of steel plates are discussed. Ways of obtaining thinner, wider plates are described. The rolling process itself and control systems regarding the control of crown and flatness are outlined. On-line parameter estimation in pass scheduling for plate rolling is discussed. Rolling of wide thin plates using the profile and shape vector method is outlined. The pass scheduling method presented is that for use on a 3.6 m wide mill. Details of modeling and constructing the control system are described. ESA

# 27 NONMETALLIC MATERIALS

Includes physical, chemical, and mechanical properties of plastics, elastomers, lubricants, polymers, textiles, adhesives, and ceramic materials.

For composite materials see *24 Composite Materials*.

**N90-23540** Pennsylvania State Univ., University Park.
**MECHANICS OF NECKING, CRAZING, AND CRACK GROWTH IN POLYMERS Ph.D. Thesis**
Leif-Olof Henrik Fager 1989 265 p
Avail: Univ. Microfilms Order No. DA8922495

The tendency of most thermoplastics to fracture in a macroscopically brittle manner is linked to the formation of small elongated crack-like cavities termed crazes. True cracks form when the fibrillar structure in these crazes breaks down. Crack growth in polymers is thus intimately connected to the growth of crazes. The fibril elongation process is analogous to propagation of stable necks in polymer tensile specimens. In the first part, quasi-static neck propagation in plane strain tension is studied. For a J(sub 2-) flow theory material a finite element solution characterized the complete development of a stable neck in an initially smooth specimen. Subsequently the effects of strain-induced heating on the necking process is investigated by assuming adiabatic heating conditions. The thermal softening, which increases the stretch in the neck and decreases the propagation load, can be strong enough to prevent stable necks to form. This change in behavior, termed the necking/drawing-necking/rupture transition, occurs when the ambient temperature is lowered. In the second part a cohesive zone model is applied to craze and crack growth under small scale yielding conditions. A time-independent constitutive description of the craze material is based on the observed necking behavior. The onset of crack growth is predicted by incorporating a displacement based damage model and a critical COD fracture criterion. The cohesive zone model is analyzed in terms of nonlinear, singular integral equations. Stable crack-craze growth is investigated by assuming a power-law creeping craze material. For the case of no damage and steady-state crack growth a logarithmic stress singularity at the crack tip is predicted. The calculated stress distributions and craze profiles show good qualitative agreement with actual crazes in high density polyethylene. Dissert. Abstr.

**N90-23541*** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**CERAMIC HEAT PIPE WICK Patent**
Benjamin Seidenberg, inventor (to NASA) and Theodore Swanson, inventor (to NASA) 28 Nov. 1989 7 p Filed 31 Jan. 1989
Supersedes N90-15261 (28 - 7, p 910)
(NASA-Case-GSC-13199-1; US-Patent-4,883,116;
US-Patent-Appl-SN-304147; US-Patent-Class-165-104.26;
US-Patent-Class-165-905; US-Patent-Class-165-41;
US-Patent-Class-122-366; Int-Patent-Class-F28D-15/02) Avail: US Patent and Trademark Office CSCL 11C

A wick for use in a capillary loop pump heat pipe is disclosed. The wick material is an essentially uniformly porous, permeable, open-cell, silicon dioxide/aluminum oxide inorganic ceramic foam having a silica fiber ratio, by weight, of about 78 to 22, respectively, a density of 6 lbs/cu ft, and an average pore size of less than 5 microns. A representative material having these characteristics is Lockheed Missile and Space Company, Inc.'s HTP 6-22. This material is fully compatible with the freons and anhydrous ammonia and allows for the use of these very efficient working fluids, and others, in capillary loops.

Official Gazette of the U.S. Patent and Trademark Office

**N90-23542#** Castrol Ltd., Reading (England). Technology Group Special Products.
**ELASTOMER COMPATIBILITY STUDIES**
Jane vanTilborg 1 Oct. 1985 138 p
(Contract MOD-CB-A42B-600)
(BR106069; ETN-90-96444) Avail: NTIS HC A07/MF A01

With the aim of a better understanding of a field problem concerning elastomer compatibility, work is carried out using a novel elastomeric (fluorocarbon) material of high temperatures, with three commercially available gas turbine lubricants. A study program was set up to consider the composition of both gas turbine lubricants, and elastomers, and interactions between the two over a range of temperatures. The Castrol gas turbine lubricant was compared with a number of others currently used in UK service. Considerations inherent in design of a gas turbine lubricant and typical composition are described. Composition of several types of fluorocarbon elastomer, with which lubricant compatibility is required, are investigated. Experimental methods used to determine elastomer/lubricant compatibility are described. ESA

**N90-23543*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**CONTROLLED CRACK GROWTH SPECIMEN FOR BRITTLE SYSTEMS**
Anthony M. Calomino and David N. Brewer (Army Aviation Systems Command, Cleveland, OH.) May 1990 10 p
(DA Proj. 1L1-61102-AH-45)
(NASA-TM-103126; E-5454; NAS 1.15:103126;
AVSCOM-TR-90-C-009) Avail: NTIS HC A02/MF A01 CSCL 11F

A pure Mode 1 fracture specimen and test procedure has been developed which provides extended, stable, through-thickness crack growth in ceramics and other brittle, nonmetallic materials. Fixed displacement loading, applied at the crack mouth, promotes stable crack extension by reducing the stored elastic strain energy. Extremely fine control of applied displacements is achieved by utilizing the Poisson's expansion of a compressively loaded cylindrical pin. Stable cracks were successfully grown in soda-lime glass and monolithic Al2O3 for lengths in excess of 20 mm without uncontrollable catastrophic failure. Author

**N90-23544*** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**NONINTRUSIVE METHOD AND APPARATUS FOR MONITORING THE CURE OF POLYMERIC MATERIALS Patent**
David F. Johnston, inventor (to NASA) and Robert L. Fox, inventor (to NASA) 2 Jan. 1990 8 p Filed 16 Feb. 1988
(NASA-Case-LAR-13465-1; US-Patent-4,891,591;
US-Patent-Appl-SN-133413; US-Patent-Class-324-234;
US-Patent-Class-264-40.1; US-Patent-Class-324-236;
US-Patent-Class-526-60; Int-Patent-Class-G01N-27/72;
Int-Patent-Class-G01R-33/12; Int-Patent-Class-G01R-27/00)
Avail: US Patent and Trademark Office CSCL 11C

The invention is a nonintrusive method of monitoring the cure of a polymeric material using an electromagnetic field to sense a change of resistance of the polymeric material in the electromagnetic field that occurs during curing. This change of resistance is used to vary the impedance of an alternating voltage power supply that produces the electromagnetic field and which change of impedance is measured periodically or continuously to monitor the cure of said polymeric material. The apparatus for practicing the method of this invention may include a nonintrusive sensing head providing an inner, electromagnetic core within an

open ended outer pot formed of magnet material. The open end of the pot core is positioned from a selected area of the surface of a sheet of the polymeric material. An alternating voltage supply circuit includes an inductance coil around the electromagnetic core and capacitor connected in parallel with the inductance coil forms a resonant tank circuit when energized. The resulting change in resistance of the polymeric material opposite the open end, a function of the curing, is measured as a corresponding change in the impedance of the power supply circuit to thereby monitor the cure of the polymeric material in the selected area.

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**N90-23545*** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

**ACETYLENE TERMINATED ASPARTIMIDES AND RESINS THEREFROM Patent**

Paul M. Hergenrother, inventor (to NASA), John W. Connell, inventor (to NASA), and Stephen J. Havens, inventor (to NASA) (PRC Kentron, Inc., Hampton, VA.) 26 Dec. 1989 20 p Filed 24 Mar. 1989 Continuation-in-part of abandoned US-Patent-Appl-SN-087375, filed 20 Aug. 1987
(NASA-Case-LAR-14188-1; US-Patent-4,889,912;
US-Patent-Appl-SN-328392; US-Patent-Appl-SN-087375;
US-Patent-Class-528-125; US-Patent-Class-548-520;
US-Patent-Class-528-126; US-Patent-Class-528-128;
US-Patent-Class-528-171-175; US-Patent-Class-528-212) Avail: US Patent and Trademark Office CSCL 11C

Acetylene terminated aspartimides are prepared using two methods. In the first, an amino-substituted aromatic acetylene is reacted with an aromatic bismaleimide in a solvent of glacial acetic acid and/or m-cresol. In the second method, an aromatic diamine is reacted with an ethynyl containing maleimide, such an N-(3-ethynyl phenyl) maleimide, in a solvent of glacial acetic acid and/or m-cresol. In addition, acetylene terminated aspartimides are blended with various acetylene terminated oligomers and polymers to yield composite materials exhibiting improved mechanical properties.

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**N90-23546*** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

**PROCESS FOR LOWERING THE DIELECTRIC CONSTANT OF POLYIMIDES USING DIAMIC ACID ADDITIVES Patent**

Diane M. Stoakley, inventor (to NASA) and Anne K. St.Clair, inventor (to NASA) 23 Jan. 1990 8 p Filed 1 Sep. 1988
(NASA-Case-LAR-13902-1; US-Patent-4,895,972;
US-Patent-Appl-SN-239259; US-Patent-Class-528-353;
US-Patent-Class-528-125; US-Patent-Class-528-126;
US-Patent-Class-528-128; US-Patent-Class-528-172;
US-Patent-Class-528-185; US-Patent-Class-528-188) Avail: US Patent and Trademark Office CSCL 11C

Linear aromatic polyimides with low dielectric constants are produced by adding a diamic acid additive to the polyamic acid resin formed by the condensation of an aromatic dianhydride with an aromatic diamine. The resulting modified polyimide is a better electrical insulator than state-of-the-art commercially available polyimides.

Official Gazette of the U.S. Patent and Trademark Office

**N90-23547#** McDonnell-Douglas Corp., Huntington Beach, CA.

**HYPUF UPGRADE Final Report, 1 Jul. 1986 - 30 Nov. 1988**

David L. Johnson 1 Feb. 1990 163 p
(Contract DNA001-85-C-0363)
(AD-A218400; MDC-H5234; DNA-TR-89-25) Avail: NTIS HC A08/MF A01 CSCL 20/11

This report describes efforts accomplished to upgrade the public domain stress wave response code, HYPUF. The elastic-viscoplastic, Maxwell dispersion and Bade geometric dispersion material response models were implemented in HYPUF. Numerous errors in the equation of state and ionization equation of state routines were corrected. Finally, the code was restructured to facilitate implementation of a P-alpha material response model and incorporation of a tabular equation of state such as SESAME. It is recommended that a simple P-alpha model for the response of distended materials and the SESAME tabular equation of state be incorporated into HYPUF. GRA

**N90-23548#** Army Lab. Command, Watertown, MA. Material Technology Lab.

**QUALITY EVALUATION OF COATINGS BY AUTOMATIC SCRATCH TESTING Final Report**

Kirit J. Bhansali and Theo Z. Kattamis (Connecticut Univ., Storrs.) Nov. 1989 23 p
(AD-A219331; MTL-TR-89-98) Avail: NTIS HC A03/MF A01 CSCL 11/3

The soundness and comparative quality of various coatings were evaluated with a CSEM-Revetest automatic scratch tester. These coatings were: TiB2 on MP35N alloy, TiN on PH 17-4 steel, on PH 17-4 steel, and plasma-enhanced CVD-processed SiC on 4340 low alloy steel. During scratch testing, the acoustic emission signal intensity, the frictional or tangential force, and the friction coefficient were plotted versus load, as well as time at various constant loads. Scratch test results were correlated with coating microstructure which was investigated by optical and scanning electron microscopy (SEM). Significant difference in quality and soundness was detected for TiN coatings processed by two different methods. This difference was confirmed by abrasive wear resistance measurements. GRA

**N90-23549#** Minnesota Univ., Minneapolis. Corrosion Research Center.

**EVALUATION OF ION INTERCALATION IN CONDUCTING POLYMERS Technical Report, 1 Jan. 1989 - 25 Jan. 1990**

Mary M. Lien, Zhi Deng, Katsuhiko Naoi, and William H. Smyrl 25 Jan. 1990 4 p
(Contract N00014-88-K-0360)
(AD-A219423; TR-24-ONR) Avail: NTIS HC A01/MF A01 CSCL 07/6

Redox(polyvinlyferrocene) and conducting polymer films (poly-3-methylthiophene and polypyrrole) were shown to insert anions and/or cations reversibly during redox cycling in order to maintain charge neutrality. Ionic motions across these polymer films have been attempted with the use of 2 techniques, viz., cyclic voltammetric measurements of effects of electrolyte concentration on shifts in E(peak) based on the Nerst equation and quartz crystal microbalance gravimetry. GRA

**N90-23550#** Minnesota Univ., Minneapolis. Corrosion Research Center.

**XPS STUDIES OF DOPED POLYPYRROLE FILMS Technical Report, 1 Jan. 1989 - 25 Jan. 1990**

Ljiljana Atanasoska, Katsuhiko Naoi, and William H. Smyrl 25 Jan. 1990 4 p
(Contract N00014-88-K-0360)
(AD-A219424; TR-21-ONR) Avail: NTIS HC A01/MF A01 CSCL 07/6

X ray photoelectron spectroscopy was used to characterize electropolymerized polypyrrole films doped with monomeric Perchlorate and polymeric, poly(vinylsulfonate) and poly(4-styrensulfonate) anions. Electrostatic interaction between the polymer and the incorporated anions involves the whole pyrrole ring rather than specific nitrogen heteroatom sites only. ClO4(-) counterions have a planar configuration and are incorporated parallel to the planar rings. On the other hand, the large polymeric counterions are more randomly distributed around polymeric chain. After sputtering, counterions were found to be randomly distributed along the polymer chain. The analysis of the XPS data which leads to these conclusions will be discussed. GRA

**N90-23551#** International Business Machines Corp., San Jose, CA.

**SOLUBLE POLYSILANES: A NEW CLASS OF RADIATION SENSITIVE O2-RIE RESISTANT POLYMERS FOR USE IN MICROLITHOGRAPHY Final Report, Apr. 1985 - Sep. 1989**

R. D. Miller 12 Mar. 1990 28 p

(Contract N00014-85-C-0056)
(AD-A219476) Avail: NTIS HC A03/MF A01 CSCL 07/2

The progress in the synthesis, characterization and spectroscopy of soluble polysilanes and germanes is described. It includes polymer structural studies, theoretical investigations of electronic structure and mechanistic studies of the photodecomposition. It also describes the potential of these materials as polymeric photoconductors, and as new materials for microlithography. The initial work on the nonlinear optical characteristics of these materials is also included. GRA

**N90-23552#** Virginia Polytechnic Inst. and State Univ., Blacksburg.
**CHARACTERIZATION AND PROCESSING OF BLENDS OF POLYETHYLENE TEREPHTHALATE WITH SEVERAL LIQUID CRYSTALLINE POLYMERS**
A. M. Sukhadia, D. Done, and D. G. Baird 1989 6 p
(Contract DAAL03-88-K-0104)
(AD-A219565) Avail: NTIS HC A02/MF A01 CSCL 07/6

The blending of thermotropic copolyesters with polyethyleneterephthalate (PET) in an effort to reinforce PET and thereby improve its modulus is discussed. The success of the technique rests on the viscosity of the liquid crystalline polymer (LCP) being lower than that of PET over the processing temperature range. In cases where the LCP was too miscible with PET the processing window for forming fibril reinforcement was too narrow and the LCP became dispersed. The modulus of drawn films was increased by a factor of 4 with the presence of a copolyester consisting of 70 mole percent Parahydroxybenzoic acid/30 mole percent PET. GRA

**N90-23553#** Lehigh Univ., Bethlehem, PA.
**HIGH TEMPERATURE MICROHARDNESS TESTER Final Report**
Helen M. Chan Jan. 1990 13 p
(Grant AF-AFOSR-0106-89; AF Proj. 2917)
(AD-A219567; AFOSR-90-0315TR) Avail: NTIS HC A03/MF A01 CSCL 11/2

Funds were obtained for the purchase of a hardness machine capable of indenting at elevated temperatures. The instrument selected was the Nikon High Temperature Microhardness Tester, Model QM. This apparatus has an operating range from room temperature to 1600 C, with loads varying from 0.5 to 10 Newtons. The instrument is now installed and fully operational. It represents a very valuable and convenient method of evaluating the indentation properties of ceramics at elevated temperatures. Although presently at a preliminary stage, the indentation creep studies look particularly promising as a means of studying the high temperature mechanical behavior. GRA

**N90-23554#** Army Belvoir Research and Development Center, Fort Belvoir, VA. Materials Fuels and Lubricants Lab.
**INFORMATION COMPENDIUM ON NONFLAMMABLE HYDRAULIC FLUID AND DESIGN REQUIREMENTS FOR ITS ADOPTION Final Report, 1978 - 1989**
Constance VanBrocklin Feb. 1990 72 p
(DA Proj. 1L7-62733-AH-20)
(AD-A219569; BRDEC-2486) Avail: NTIS HC A04/MF A01 CSCL 11/8

The purpose of this report is to provide developers of future Army equipment with the information necessary to design systems capable of using a nonflammable hydraulic fluid (NFH) which has a chlorotrifluoroethylene (CFTE) base stock. This hydraulic fluid is described in Air Force draft specification, MIL-H-XXXX Hydraulic Fluid, Nonflammable, Chlorotrifluoroethylene Base for Aircraft. The fluid's characteristics and how they will affect the design of the hydraulic system are discussed, along with testing research data, and conclusions. In addition, system design changes which are required to accommodate this new fluid are suggested. A comprehensive annotated bibliography of the NFH/CTFE development efforts is included. GRA

**N90-23555#** Wright Research Development Center, Wright-Patterson AFB, OH. Polymer Branch.
**GRAFT COPOLYMERS OF RIGID-ROD POLY(P-PHENYLENEBENZOBISIMIDAZOLE) Final Report, Jun. 1986 - Jun. 1987**
Robert C. Evers, Thuy D. Dang, and D. Roger Moore (Universal Energy Systems, Inc., Dayton, OH.) Feb. 1990 19 p Sponsored by AFSC, Wright-Patterson AFB, OH
(AF Proj. 2303)
(AD-A220369; WRDC-TR-90-4003) Avail: NTIS HC A03/MF A01 CSCL 07/6

Poly(p-phenylenebenzobisimidazole) with a pendent 2-benzothiazole group (PPBI) was dissolved in dimethylsulfoxide through reaction with sodium methylsulfinylmethide. Propylene oxide was reacted with the resultant benzimidazole anions to give a graft copolymer with a rigid-rod backbone and flexible polypropylene oxide (PPO) side-chains. In some cases, graft copolymers with greater than 50 percent PPO content by weight were obtained. Although the thermooxidative stability of the PPBI was substantially reduced through the incorporation of PPO into the polymer structure, solubility in organic solvents and fusibility were substantially improved. Through processing at elevated temperatures (374 to 450 F) and moderate pressures (500 to 750 pounds per square inch), molded specimens could be prepared from the neat graft copolymers. GRA

**N90-23556#** Army Materials Technology Lab., Watertown, MA. Ceramics Research Branch.
**FRACTURE MECHANISM MAPS FOR ADVANCED STRUCTURAL CERAMICS. PART 1: METHODOLOGY AND HOT-PRESSED SILICON NITRIDE RESULTS Final Report**
George D. Quinn Feb. 1990 35 p
(DA Proj. 1L1-62105-AH-84)
(AD-A220428; MTL-TR-90-6-Pt-1) Avail: NTIS HC A03/MF A01 CSCL 11/2

The static fatigue behavior of advanced structural ceramics can be controlled by a variety of failure mechanisms. A fracture mechanism map can define the stress-temperature regimes where the different mechanisms are dominant. The static fatigue resistance of a hot-pressed silicon nitride with magnesia sintering aid is limited by slow crack growth or creep fracture, depending upon the specific stress-temperature conditions. The flexural fracture map is considerably refined relative to earlier versions, and in conjunction with available tension data, was used to create a tension fracture map. The fracture map brings together the findings of a number of studies and can be appreciated by materials scientists and engineers. GRA

**N90-23557#** Aerospace Corp., El Segundo, CA. Chemistry and Physics Lab.
**ELECTRONIC STRUCTURE AND LUBRICATION PROPERTIES OF MoS2: A QUALITATIVE MOLECULAR ORBITAL APPROACH**
Paul D. Fleischauer, Jeffrey R. Lince, P. A. Bertrand, and Reinhold Bauer 21 Mar. 1990 40 p
(Contract F04701-85-C-0086)
(AD-A220566; TR-0088(3945-03)-1; SSD-TR-90-09) Avail: NTIS HC A03/MF A01 CSCL 11/8

The electronic structure of the solid lubricant material MoS2 is described by a qualitative molecular orbital (MO) model that is based on the D2h symmetry of the Mo(S)6 unit in the crystal. The MO model is used to assign peaks in the valence-level photoelectron spectrum (VLPS) and the electron energy loss spectrum of MoS2(0001) and to interpret the effects of ion bombardment (IB) of this surface on its electronic structure. The dependence of VLPS peak intensities on excitation energy is used to assign the energy levels in the MO diagram. Variations in crystal lattice spacing within sputter-deposited MoS2 films are explained in terms of electron density arguments. Structural information, together with information on surface bonding and on adhesion from the IB studies, aids in predicting the lubrication performance of these films. It is proposed that the highest occupied orbital for MoS2 is an Al nonbonding orbital and that important film properties,

such as adhesion to substrates and friction within the film, can be manipulated by altering the electron occupancy of this orbital.
GRA

**N90-23558#** Wright Research Development Center, Wright-Patterson AFB, OH. Polymer Branch.
**THERMAL ANALYSIS OF ACETYLENE TERMINATED SULFONE (ATS) RESIN Final Report, Jan. 1981 - Jun. 1983**
W. T. K. Stevenson, I. J. Goldfarb, and E. J. Soloski 18 Jan. 1990 229 p
(AF Proj. 2303)
(AD-A220775; AFWAL-TR-89-4001) Avail: NTIS HC A11/MF A02 CSCL 07/6

A number of new thermo-analytical techniques for the elucidation of kinetic and mechanistic aspects of the decomposition of thermally stable polymers under high vacuum conditions are described herein, with particular reference to their use in conjunction with more conventional techniques of organic structural analysis to gain a more comprehensive insight into the degradation process. In addition to general procedures, some approaches geared specifically to the thermal analysis of acetylene terminated sulfone (ATS) resins are also detailed. A compositional analysis of volatiles flashed from thin films of ATS-G prepolymer is used to assess the purity of the feedstock used to prepare ATS-G, and to propose the existence of some preparative side reactions. A brief description of the cure process of ATS-G is followed by a more complex study of the post cure step and its overlap with low temperature degradations in the polymer. Finally, a fairly comprehensive mechanism of accelerated high temperature thermal degradation of ATS-G and its component fractions. With particular reference to the influence of the sulfone linkage as a (relatively) unstable thermal weak link, and the polyene crosslink (or its thermal derivative) on the weight loss processes operative within the basic polyphenylether constituent of the polymer.
GRA

**N90-23559#** Nu-Tech Industries, Inc., Dayton, OH.
**DURABLE HEAT DIAPHRAGM FROM ORDERED POLYMER FILMS Final Report, 25 Jul. 1988 - 25 Nov. 1989**
Anthony P. Lioi May 1990 43 p
(Contract F33615-88-C-5468; AF Proj. 3005)
(AD-A220794; WRDC-TR-90-4020) Avail: NTIS HC A03/MF A01 CSCL 06/12

The purpose of the study was to investigate the feasibility of using the ordered polymer-p-phenylene benzobisthiazole (PBZT) in high flex-life applications. Applications of particular interest include biomedical applications such as the artificial heart or prosthetic heart valves. An accelerated flex-life test rig based on a vibration principle was developed that was capable of subjecting film samples to over 3 million flexural cycles per 24 hr period. Film samples were prepared of neat PBZT and of PBZT in an interpenetrating network (IPN) with silicone and with polyurethane. The IPN with polyurethane was also subjected to biocompatibility screening tests. The results demonstrated the capability of the accelerated life test rig to provide high cycle rate and adequate flexure to fatigue the film samples. The test was run for 100 million cycles. Information obtained indicated that flex-life of PBZT was improved by forming an IPN with a polyurethane. Biocompatibility screening tests demonstrated feasibility of using the material in contact with blood. The study indicated there is a potential for a high flex-life material to be made from ordered polymers formed in an IPN with polyurethane. Since other ordered polymers of same family have an even greater potential for high flex life, the results of this study suggest that a superior material for high flex-life applications may be achieved. GRA

**N90-23560#** Defence Research Establishment Pacific, Victoria (British Columbia). Research and Development Branch.
**AN INVESTIGATION OF THE CHEMISTRY OF SILANE COUPLING AGENTS FOR ADHESIVE BONDING OF ALUMINUM**
Gregory R. Peters and Greg A. Luoma Oct. 1989 23 p
(AD-A220797; DREP-TM-89-24) Avail: NTIS HC A03/MF A01 CSCL 11/1

Adhesive bonding is gaining increasing attention as an alternative to more traditional methods such as welding and rivetting for in-field and permanent repair of military equipment. A major concern with adhesive bonding of metals such as aluminum is achieving reproducible high bond strengths when using epoxy adhesives. A number of commercially available silane, titanate and zirconate coupling agents have been proposed to chemically interact with both the aluminum surface and the adhesive, and thereby increase bond strength. This study was conducted to determine which of these coupling agents when used with Defense Research Establishment Pacific (DREP) proprietory adhesives would provide the greatest improvements in bond strength the best chemical form to apply the coupling agents, and the chemical basis for the improvements in bond strength. Results indicate that a particular silane coupling agent (gamma-GPS) provides the greatest improvements in bond strength when applied from an ethanolic solution. Surprisingly, the studies indicate that the unhydrolyzed silane is more effective as a coupling agent for bonding aluminum with epoxy adhesives than the hydrolyzed form. This latter observation suggests that there is no direct chemical bonding of the aluminum surface to the coupling agent. GRA

**N90-23561#** Aeronautical Research Inst. of Sweden, Stockholm. Dept. of Structures.
**FATIGUE TESTING OF GLASS FIBRE REINFORCED EPOXY USING THE WISPER SEQUENCE**
Maria Poppen Nov. 1989 16 p Sponsored by Swedish National Energy Administration
(FFA-TN-1989-45; ETN-90-96602) Avail: NTIS HC A03/MF A01

Spectrum fatigue loading of the glassfiber/epoxy material used in the Maglarp wind turbine blades is discussed. The spectrum used is WISPER, a standardized wind turbine spectrum. Comparison of the spectrum data with the constant amplitude data was performed. The results indicate that Palmgren-Miner's rule is overly conservative. Damage sums up to the order of 20 were experimentally found. These sums were found to be dependent on load levels used, which makes the application of Palmgren-Miner calculations questionable for real structural components. ESA

**N90-23562#** Hunter Coll., New York, NY. Dept. of Physics.
**NMR STUDIES OF POLYMERIC SOLID ELECTROLYTES Final Report, Dec. 1983 - Sep. 1989**
S. G. Greenbaum 16 Mar. 1990 4 p
(Contract N00014-85-K-0304; NR Proj. 627-846)
(AD-A219833) Avail: NTIS HC A01/MF A01 CSCL 07/4

A wide variety of polymer electrolytes containing mobile sodium (+) ions were studied by sodium 23 NMR. Motional averaging of the NMR linewidth above T(g) and subsequent lifetime broadening about 60K above T(g) was found to be common to all polymer hosts studied, including cross-linked PEO, PPO, MEEP and siloxane-PEO copolymers. Other highlights include the synthesis and study of single ion (cation) conductors, the development of high-pressure NMR capability, and the use of ESR to study ionic motion in copper(2+) containing polymer electrolytes. Li ion conductors in conjunction with the Li-thionyl chloride battery program is being studied. The deuteron NMR work provided valuable guidance in determining the phase diagram in frozen aqueous KOH solutions. An interesting spin-off of this work was recently published study of deuteron NMR in polyimide films containing water. GRA

**N90-23563#** Connecticut Univ., Storrs. Dept. of Chemical Engineering.
**THE ORIGIN OF MULTIPLE MELTING IN POLYURETHANE BLOCK COPOLYMERS**
A. F. Galambos, T. P. Russell (International Business Machines Corp., San Jose, CA.), and Jeffrey T. Koberstein 27 Mar. 1990 9 p Presented at the North American Thermal Analysis Meeting, San Diego, CA, 24-27 Sep. 1989

(Contract N00014-86-K-0497)
(AD-A220050; TR-3) Avail: NTIS HC A02/MF A01 CSCL 07/6

The morphology of multiphase polymeric materials is often a strong function of temperature as well as thermal history. For example, the temperatures at which apparent multiple melting endotherms are observed in some materials are found to be sensitive to the thermal annealing conditions. The availability of synchrotron radiation sources makes possible the collection of small and wide angle x ray scattering data during a differential scanning calorimetry experiment. The technique is applied to examine the possible origins of multiple endotherms and annealing induced morphological changes in segmented polyurethane - poly(ether-ester) copolymers. The results of the polyurethane experiments are compared to thermal-mechanical measurements of softening behavior, from which a number of structure-property relations may be inferred. GRA

**N90-23564#** Connecticut Univ., Storrs. Dept. of Chemical Engineering.
**COMPRESSION MOLDED POLYURETHANE BLOCK COPOLYMERS. 3: EVALUATION OF MICROPHASE COMPOSITIONS**
Jeffrey T. Koberstein and Louis M. Leung (Princeton Univ., NJ.) 27 Mar. 1990 38 p Submitted for publication
(Contract N00014-86-K-0497; NSF DMR-81-05612)
(AD-A220160; TR-8) Avail: NTIS HC A03/MF A01 CSCL 07/6

This paper presents methods to estimate the microphase compositions in polyurethane segmented block copolymers based upon combined analyses by small-angle x ray scattering and differential scanning calorimetry. The methods are applied to a system of polyurethanes prepared from 4,4'-diphenylmethane diisocyanate, 1,4-butanediol, and a 2000 MW ethylene glycol capped polypropylene oxide prepolymer. The resultant microphase compositions predict microphase transition temperatures that compare well with observed values. The versatile mechanical properties of segmented polyurethane elastomers are generally attributed to the formation of a microphase separated structure due to incompatibility of the glassy hard segment and rubbery soft segment sequences. From these results, it appears that the morphological behavior of polyurethanes is strongly dependent on polydispersity. In monodisperse model compounds, extend chains are predominant, while in normal segmented polyurethanes, the evidence supports the occurrence of some type of hard segment chain folding or reentry into the hard microdomain. GRA

**N90-23565#** Naval Weapons Center, China Lake, CA.
**PREPARATION, PROPERTIES, AND DEVELOPMENT OF CALCIUM LANTHANUM SULFIDE AS AN 8- TO 12-MICROMETER TRANSMITTING CERAMIC Final Report, 1985-1988**
Marian E. Hills Sep. 1989 44 p
(AD-A220200; AD-E900956; NWC-TP-7037) Avail: NTIS HC A03/MF A01 CSCL 20/6

The purpose of this report is to document work done on the development of calcium lanthanum sulfide (CaLa2S4) as an infrared (IR) dome material for use in the 8- to 12-micrometer region. GRA

**N90-23566*** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
**LIGHTWEIGHT CERAMIC INSULATION AND METHOD Patent**
David J. Green, inventor (to NASA) (Rockwell International Corp., Houston, TX.) 24 Apr. 1990 4 p Filed 30 Jun. 1988 Supersedes N89-13620 (27 - 5, p 618)
(NASA-Case-MSC-20782-1; US-Patent-4,919,852; US-Patent-Appl-SN-213392; US-Patent-Class-264-6; US-Patent-Class-264-11; US-Patent-Class-264-43; US-Patent-Class-264-28; Int-Patent-Class-B29B-33/02) Avail: US Patent and Trademark Office CSCL 11C

A process is disclosed for manufacturing a low density ceramic powder which can be formed to make a lightweight material for insulation or other construction. The ceramic product made from the process has a final density of less than 25 to about 1 percent of the theoretical weight of the ceramic powder. The ceramic product is lightweight and can be made to withstand high temperatures greater than 1400 C.
Official Gazette of the U.S. Patent and Trademark Office

**N90-23567#** Technische Univ., Delft (Netherlands).
**SPECTRALLY SELECTIVE TINOXIDE AND INDIUMOXIDE COATINGS Ph.D. Thesis**
Han Haitjema 1989 247 p Sponsored in part by Netherlands Technology Foundation
(ISBN-90-9003138-3; ETN-90-96902) Avail: NTIS HC A11/MF A02

The coatings were investigated to determine the physical properties which govern the spectrally selective behavior and the limits of the selectivity which can be achieved in theory and practice. Measuring techniques used include spectrophotometry, Hall-effect determinations, ellipsometry, and the emittance determination of the angle-dependent thermal emittance. Methods in which the optical constants and the thickness of the coatings were determined are compared. The pyrolis process by which the coatings were produced is described. Results for effects of fluorine doping, coating thickness and process parameters on tinoxide are compared with those for effects of tin doping, annealing and coating thickness on indiumoxide. The main conclusion is that a thermal emittance combined with a solar absorptance of 0.92 is the limit achievable when preparing doped SnO2 or In2O3 coatings under optimum conditions. ESA

**N90-23568#** Ecole Centrale de Lyon (France). Lab. de Technologie des Surfaces.
**DEVELOPMENT OF A DEVICE FOR SURFACE TENSION MEASUREMENT AND PHENOMENOLOGICAL RHEOLOGY Ph.D. Thesis [DEVELOPPEMENT D'UN APPAREIL DE MESURE DE FORCES DE SURFACE ET DE NANORHEOLOGIE]**
Andre Tonck 1989 105 p In FRENCH
(ECL-89-12; ETN-90-96945) Avail: NTIS HC A06/MF A01

A measuring device to be used in studying the mechanical and electrical interactions between surfaces and a lubricant film is presented. Several simultaneous readings can be taken using this instrument. A technique for taking the elasticity of the solid surfaces into account during measurement is proposed. Initial results are in agreement with those of Israelachvili, but differences are found in that the oscillations are replaced by a continuously building force. This difference is concluded to be due to the rugosity of the surfaces used. ESA

# 28 PROPELLANTS AND FUELS

Includes rocket propellants, igniters, and oxidizers; their storage and handling procedures; and aircraft fuels.

For related information see also *07 Aircraft Propulsion and Power, 20 Spacecraft Propulsion and Power,* and *44 Energy Production and Conversion.*

**N90-23569#** Vanderbilt Univ., Nashville, TN.
**WORKSHOP ON ESD (ELECTROSTATIC DISCHARGE) IGNITION OF COMPOSITE SOLID PROPELLANTS Final Report, 1 Feb. 1989 - 31 Jan. 1990**
A. M. Mellor, D. R. Dreitzler, R. W. Larson, and D. M. Mann (Army Research Office, Research Triangle Park, NC.) Jan. 1990 169 p Workshop held in Nashville, TN, 18-19 Apr. 1989
(Contracts DAAL03-87-C-0021; DAAL03-89-G-0015)
(AD-A218599; ARO-26759.1-RH-EG) Avail: NTIS HC A08/MF A01 CSCL 21/9

A mechanism for an electrostatic discharge (ESD) initiation of a solid rocket motor is presented, based largely on discussions at a recent workshop focussed on ESD ignition of composite propellants. Electrical property measurements and breakdown phenomena have enjoyed most attention to data and did at the meeting as well. Here overviews of the formal workshop

presentations are given, but the main emphasis is to convey the flow of the discussions, which included proposals on new ignition experiments now required, as well as preliminary thoughts on formulation of an ignition model. Based on the informal discussions, a recently proposed, detailed physical mechanism for ESD ignition is modified somewhat to be more consistent with experimental observations. GRA

**N90-23570#** Michigan Univ., Ann Arbor. Dept. of Aerospace Engineering.
**STRUCTURE OF MONOPROPELLANT SPRAY FLAMES AT ELEVATED PRESSURES Final Report, 1 Sep. 1986 - 31 Dec. 1989**
G. M. Faeth, T.-W. Lee, M. E. Kounalakis, and L.-K. Tseng 15 Jan. 1990 89 p
(Contract DAAL03-86-K-0154)
(AD-A218676; GDL/GML-90-01; ARO-24076.8-EG) Avail: NTIS HC A05/MF A01 CSCL 21/2

The combustion properties of HAN-based monopropellants (LGP1845 and 1846) were studied, considering: liquid surface properties and conditions required for the thermodynamic critical point to be reached, drop combustion properties in combustion gas environments at pressures of 0.2 to 7.0 MPa, and pressure-atomized spray combustion properties in combustion gas environments at pressures of 3 to 9 MPa. Computations of liquid surface properties in flame environments indicated unusually high liquid surface temperatures, ca. 1000K, and critical combustion pressures, ca. 250 MPa, since these propellants have thermodynamic properties similar to molten salts. Drop burning was dominated by subsurface reaction leading to bubble formation and microexplosions which mechanically removed liquid, at low pressures (less that 2.1 MPa); and conventional hetereogeneous combustion from the surface at high pressures (greater than 2.1 MPa). The resulting apparent burning rates were relatively independent of pressure and were large, ca. 10 mm/s, which is consistent with earlier strand burning rate measurements of jelled propellants at pressures greater than 10 MPa by McBratney (1980, 1981). Measurements of drop size distributions, liquid flow rates, and liquid mass fluxes in combusting sprays were consistent with the individual drop burning rate measurements and exhibited strong effects of separated flow. GRA

**N90-23571#** Edgerton, Germeshausen and Grier, Inc., Idaho Falls, ID. National Engineering Lab.
**THREE-DIMENSIONAL ANALYSIS ON FLOW AND TEMPERATURE DISTRIBUTIONS FOR AIRCRAFT FUEL THERMAL STABILITY Interim Report, Aug. 1988 - Jun. 1989**
C. H. Oh, B. J. Merrill, and R. P. Wadkins Jun. 1989 70 p
(Contract FY1455-86-N-0657; AF Proj. 2480)
(AD-A219651; WRDC-TR-89-2138) Avail: NTIS HC A04/MF A01 CSCL 21/4

Flow temperature distributions in the Jet Fuel Thermal Oxidation Tester (JFTOT), a device that has been used in thermal stability research of aircraft fuels are presented. The Computational Fluid Dynamics and Chemistry (CFDC) model used is based on the global Arrhenius type surface temperature dependent correlation because of the lack of the existing experimental data. The initial attempt to calculate the deposit thickness and to simulate flow in the JFTOT is very encouraging. GRA

**N90-23572#** Army Armament Research and Development Command, Dover, NJ. Armament Engineering Directorate.
**DIFFUSION IN THE THERMAL DEGRADATION OF NC BASE PROPELLANTS Interim Report**
D. A. Wiegand Mar. 1990 19 p
(AD-A219831; ARAED-TR-89035) Avail: NTIS HC A03/MF A01 CSCL 19/1

A somewhat general discussion of diffusion in nitrocellulous base propellants is followed by a discussion of a kinetic model which predicts in a qualitative manner the features of the growth and decay of the various derivatives of 2-nitrodiphenylamine (2NDPA) during thermal degradation. GRA

**N90-23573#** Naval Weapons Center, China Lake, CA.
**NITRAMINE COMPOSITE SOLID PROPELLANT MODELLING Final Report, Dec. 1984 - Dec. 1988**
F. S. Blomshield Jul. 1989 184 p
(ONR Proj. 1601)
(AD-A220198; AD-E900942; NWC-TP-6992) Avail: NTIS HC A09/MF A01 CSCL 21/9

This report summarizes work performed at the Naval Weapons Center to develop a theoretical model for the combustion of nitramine composite solid propellants. GRA

**N90-23574*#** Rockwell International Corp., Canoga Park, CA. Rocketdyne Div.
**HEALTH MANAGEMENT SYSTEM FOR ROCKET ENGINES Final Report**
Edward Nemeth Jun. 1990 247 p
(Contract NAS3-25625)
(NASA-CR-185223; NAS 1.26:185223) Avail: NTIS HC A11/MF A02 CSCL 21I

The functional framework of a failure detection algorithm for the Space Shuttle Main Engine (SSME) is developed. The basic algorithm is based only on existing SSME measurements. Supplemental measurements, expected to enhance failure detection effectiveness, are identified. To support the algorithm development, a figure of merit is defined to estimate the likelihood of SSME criticality 1 failure modes and the failure modes are ranked in order of likelihood of occurrence. Nine classes of failure detection strategies are evaluated and promising features are extracted as the basis for the failure detection algorithm. The failure detection algorithm provides early warning capabilities for a wide variety of SSME failure modes. Preliminary algorithm evaluation, using data from three SSME failures representing three different failure types, demonstrated indications of imminent catastrophic failure well in advance of redline cutoff in all three cases. Author

# 29 MATERIALS PROCESSING

Includes space-based development of products and processes for commercial applications.
For biological materials see *55 Space Biology*.

**N90-23575*#** Alabama Univ., Huntsville.
**CONSORTIUM FOR MATERIALS DEVELOPMENT IN SPACE Annual Report, 1 Oct. 1988 - 30 Sep. 1989**
7 May 1990 53 p
(Grant NAGw-812)
(NASA-CR-186534; NAS 1.26:186534) Avail: NTIS HC A04/MF A01 CSCL 22A

The status of the Consortium for Materials Development in Space (CMDS) is reviewed. Individual CMDS materials projects and flight opportunities on suborbital and orbital carriers are outlined. Projects include: surface coatings and catalyst production; non-linear optical organic materials; physical properties of immiscible polymers; nuclear track detectors; powdered metal sintering; iron-carbon solidification; high-temperature superconductors; physical vapor transport crystal growth; materials preparation and longevity in hyperthermal oxygen; foam formation; measurement of the microgravity environment; and commercial management of space fluids. J.P.S.

**N90-23576*#** City Univ. of New York, Brooklyn. Dept. of Physics.
**PHOTOREFLECTANCE FOR IN-SITU CHARACTERIZATION OF MOCVD GROWTH OF SEMICONDUCTORS UNDER MICRO-GRAVITY CONDITIONS Final Report**
Fred H. Pollak Jun. 1990 20 p
(Grant NAG1-1028)
(NASA-CR-186600; NAS 1.26:186600) Avail: NTIS HC A03/MF A01 CSCL 22A

A contactless electromodulation technique of photoreflectance (PR) was developed for in-situ monitoring of metal-organic chemical

vapor deposition (MOCVD) semiconductor growth for micro-gravity applications. PR can be employed in a real MOCVD reactor including rotating substrate (approximately 500 rev/min) in flowing gases and through a diffuser plate. Measurements on GaAs and Ga(0.82)Al(0.18)As were made up to 690 C. The direct band gaps of In(x)Ga(1-x)As (x = 0.07 and 0.16) were evaluated up to 600 C. In order to address the question of real time measurement, the spectra of the direct gap of GaAs at 650 C was obtained in 30 seconds and 15 seconds seems feasible. Author

# 31 ENGINEERING (GENERAL)

Includes vacuum technology; control engineering; display engineering; cryogenics; and fire prevention.

**N90-23577*#** Georgia Inst. of Tech., Atlanta. School of Mechanical Engineering.
**DESIGN OF A ROTARY STEPPED AUGER FOR A LUNAR ENVIRONMENT**
Eduardo Dardet, Derek Hart, Chris Herod, Stephen Homiller, Mickey Meeks, and Kirsten Platt Mar. 1988 60 p
(Grant NGT-21-002-800)
(NASA-CR-184919; NAS 1.26:184919; ME-4182) Avail: NTIS HC A04/MF A01 CSCL 13B

A lunar outpost will have need for deep drilling operations for both explorative and practical purposes. As in any drilling operation, the cuttings must be cleared from the hole. The hard vacuum of the lunar environment renders conventional flushing methods of cutting removal unfeasible, and requires a new system of removal. A rotary stepped auger (RSA) is a simple mechanical method of removing dry cuttings from a deep hole, and is ideally suited to the lunar environment. The RSA consists of a helical auger with stepped ramps which allow cuttings to slide up the helix, but will prevent them from sliding back down. The auger is driven in a pulsed manner by applying a periodic function of acceleration to the auger shaft. These pulses will compel the cuttings to slide up the auger's helix while the stepped ramps prevent the cuttings from backsliding while the auger accelerates. A mathematical model of the RSA was developed and experimentally evaluated. The math model produced a good baseline design, but the experimental model required some tuning to account for the approximations made in the math model. This design is suited for lunar drilling because it is mechanically simple, integral to the drill string, requires no fluids, is suited to the dry soil, and has relatively low weight and power requirements. Author

**N90-23578*#** Georgia Inst. of Tech., Atlanta. School of Mechanical Engineering.
**SKITTER/IMPLEMENT MECHANICAL INTERFACE**
John Wilson Cash, III, Alan E. Cone, Frank J. Garolera, David German, David Peter Lindabury, Marshall Cleveland Luckado, Craig Murphey, John Bryan Rowell, and Brad Wilkinson Jun. 1988 70 p
(Grant NGT-21-002-800)
(NASA-CR-184920; NAS 1.26:184920; ME-4182) Avail: NTIS HC A04/MF A01 CSCL 13B

SKITTER (Spacial Kinematic Inertial Translatory Tripod Extremity Robot) is a three-legged transport vehicle designed to perform under the unique environment of the moon. The objective of this project was to design a mechanical interface for SKITTER. This mechanical latching interface will allow SKITTER to use a series of implements such as drills, cranes, etc., and perform different tasks on the moon. The design emphasized versatility and detachability; that is, the interface design is the same for all implements, and connection and detachment is simple. After consideration of many alternatives, a system of three identical latches at each of the three interface points was chosen. The latching mechanism satisfies the design constraints because it facilitates connection and detachment. Also, the moving parts are protected from the dusty environment by housing plates. Author

**N90-23579*#** Georgia Inst. of Tech., Atlanta. School of Mechanical Engineering.
**LUNAR CRANE HOOK**
John Wilson Cash, III, Alan E. Cone, Frank J. Garolera, David German, David Peter Lindabury, Marshall Cleveland Luckado, Craig Murphey, John Bryan Rowell, and Brad Wilkinson Jun. 1988 61 p Original contains color illustrations
(Grant NGT-21-002-800)
(NASA-CR-184921; NAS 1.26:184921; ME-4182) Avail: NTIS HC A04/MF A01; 8 functional color pages CSCL 13B

The base and ball hook system is an attachment that is designed to be used on the lunar surface as an improved alternative to the common crane hook and eye system. The design proposed uses an omni-directional ball hook and base to overcome the design problems associated with a conventional crane hook. The base and ball hook is not sensitive to cable twist which would render a robotic lunar crane useless since there is little atmospheric resistance to dampen the motion of an oscillating member. The symmetric characteristics of the ball hook and base eliminates manual placement of the ball hook into the base; commonly associated with the typical hook and eye stem. The major advantage of the base and ball hook system is it's ease of couple and uncouple modes that are advantages during unmanned robotic lunar missions. Author

**N90-23580*#** Georgia Inst. of Tech., Atlanta. School of Mechanical Engineering.
**TUBULAR SPACE TRUSS STRUCTURE FOR SKITTER 2 ROBOT**
Richard Beecham, Linda DeJulio, Paul DeLorme, Eric Eck, Avi Levy, Joel Lowery, Joe Radack, Randy Sheffield, and Scott Stevens May 1988 154 p
(Grant NGT-21-002-800)
(NASA-CR-184922; NAS 1.26:184922; ME-4182) Avail: NTIS HC A08/MF A01 CSCL 13B

The Skitter 2 is a three legged transport vehicle designed to demonstrate the principle of a tripod walker in a multitude of environments. The tubular truss model of Skitter 2 is a proof of principal design. The model will replicate the operational capabilities of Skitter 2 including its ability to self-right itself. The project's focus was on the use of light weight tubular members in the final structural design. A strong design for the body was required as it will undergo the most intense loading. Triangular geometry was used extensively in the body, providing the required structural integrity and eliminating the need for cumbersome shear panels. Both the basic femur and tibia designs also relied on the strong geometry of the triangle. An intense literature search aided in the development of the most suitable weld techniques, joints, linkages, and materials required for a durable design. The hinge design features the use of spherical rod end bearings. In order to obtain a greater range of mobility in the tibia, a four-bar linkage was designed which attaches both to the femur and the tibia. All component designs, specifically the body, femur, and the tibia were optimized using the software package IDEAS 3.8A Supertab. The package provided essential deformation and stress analysis information on each component's design. The final structure incurred only a 0.0544 inch deflection in a maximum (worst case) loading situation. The highest stress experienced by any AL6061-T6 tubular member was 1920 psi. The structural integrity of the final design facilitated the use of Aluminum 6061-T6 tubing. The tubular truss structure of Skitter 2 is an effective and highly durable design. All facets of the design are structurally sound and cost effective.
Author

**N90-23581*#** Georgia Inst. of Tech., Atlanta. School of Mechanical Engineering.
**LUNAR HAND TOOLS**
Karl F. Bentz, Robert D. Coleman, Kathy Dubnik, William S. Marshall, Amy McEntee, Sae H. Na, Scott G. Patton, and Michael C. West 3 Dec. 1987 75 p
(Grant NGT-21-002-800)
(NASA-CR-184924; NAS 1.26:184924; ME-4182) Avail: NTIS HC A04/MF A01 CSCL 13B

Tools useful for operations and maintenance tasks on the lunar surface were determined and designed. Primary constraints are the lunar environment, the astronaut's space suit and the strength limits of the astronaut on the moon. A multipurpose rotary motion tool and a collapsible tool carrier were designed. For the rotary tool, a brushless motor and controls were specified, a material for the housing was chosen, bearings and lubrication were recommended and a planetary reduction gear attachment was designed. The tool carrier was designed primarily for ease of access to the tools and fasteners. A material was selected and structural analysis was performed on the carrier. Recommendations were made about the limitations of human performance and about possible attachments to the torque driver. Author

**N90-23582*#** Georgia Inst. of Tech., Atlanta. School of Mechanical Engineering.
**SOIL TRANSPORT IMPLEMENT**
William Dixon, William Fan, Joey Lloyd, Nam-Anh Pham, and Michael Stevens Mar. 1988 82 p Original contains color illustrations
(Grant NGT-21-002-800)
(NASA-CR-184931; NAS 1.26:184931; ME-4182) Avail: NTIS HC A05/MF A01; 1 functional color page CSCL 13B

The design of the Soil Transport Implement (STI) for SKITTER is presented. The purpose of STI is to provide a protective layer of lunar soil for the lunar modules. The objective is to cover the lunar module with a layer of soil approximately two meters thick within a two week period. The amount of soil required to cover the module is roughly 77 dump truck loads or three million earth pounds. A spinning disk is employed to accomplish its task. STI is an autonomous, teleoperated system. The design incorporates the latest advances in composite materials and high strength, light weight alloys to achieve a high strength to weight ratio. The preliminary design should only be used to assess the feasibility of employing a spinning wheel as a soil transport implement. A mathematical model of the spinning wheel was used to evaluate the performance of this design. Author

**N90-23583*#** Georgia Inst. of Tech., Atlanta. School of Mechanical Engineering.
**PROOF OF PRINCIPAL FOR STAIRCASE AUGER CHIP REMOVAL THEORY**
Jeffrey B. Barron, Steve Brewer, Kenneth Kerns, Kyle Moody, and Richard A. Rossi Aug. 1987 58 p
(Grant NGT-21-002-800)
(NASA-CR-184934; NAS 1.26:184934; ME-4182) Avail: NTIS HC A04/MF A01 CSCL 13B

A proof of principal design of the staircase auger theory is provided for lunar drilling. The drill is designed to drill holes 30 meters deep and 0.1 meters in diameter. The action of the auger is 0.01 meter strokes at a varying number of strokes per second. A detailed analysis of the interaction of the auger and particle was done to optimize the parameters of the auger. This optimum design will allow for proper heat removal and reasonable drilling time. The drill bit is designed to scoop the particles into the auger while efficiently cutting through the moon's surface. Author

**N90-23584** Colorado Univ., Boulder.
**SIMULATION AND INTERDISCIPLINARY DESIGN METHODOLOGY FOR CONTROL-STRUCTURE INTERACTION SYSTEMS Ph.D. Thesis**
Wendell Keith Belvin 1989 165 p
Avail: Univ. Microfilms Order No. DA9009137

Computational procedures for preliminary design, synthesis, and simulation of control structure interaction systems are developed from a second-order systems viewpoint. First, a partitioned solution procedure is developed for the solution of the equations of motion with feedback controls. The computational stability and implementation aspects of the partitioned computational procedure for control-structure interaction analysis is presented. Implementation issues for enhancing both accuracy and the computational stability margin and modular programming of the procedure are addressed. Second, a computational procedure that takes advantage of the structure of second-order differential equations is developed for state estimation. It is shown that the reconstruction of system states through second-order observers is computationally more attractive than existing first-order observer models if certain mildly restrictive conditions are satisfied. Hence, the present second-order observers enable the analyst to utilize larger observer models than have been possible with first-order observer models. The third issue addressed is the integrated design of controlled structures. A method for optimization of the controlled structural system using only structural tailoring is presented. Optimal linear quadratic regulator control theory is used and the closed-loop performance is expressed in terms of structural parameters. Also, a software testbed was designed and implemented for evaluating new formulations and algorithms for controlled structural analysis and design. Dissert. Abstr.

**N90-23585*#** Illinois Univ., Urbana. Qualitative Reasoning Group.
**QUALITATIVE MODELS FOR SPACE SYSTEM ENGINEERING Final Report**
Kenneth D. Forbus Jun. 1990 75 p
(Grant NAG9-137)
(NASA-CR-180682; NAS 1.26:180682) Avail: NTIS HC A04/MF A01 CSCL 13B

The objectives of this project were: (1) to investigate the implications of qualitative modeling techniques for problems arising in the monitoring, diagnosis, and design of Space Station subsystems and procedures; (2) to identify the issues involved in using qualitative models to enhance and automate engineering functions. These issues include representing operational criteria, fault models, alternate ontologies, and modeling continuous signals at a functional level of description; and (3) to develop a prototype collection of qualitative models for fluid and thermal systems commonly found in Space Station subsystems. Potential applications of qualitative modeling to space-systems engineering, including the notion of intelligent computer-aided engineering are summarized. Emphasis is given to determining which systems of the proposed Space Station provide the most leverage for study, given the current state of the art. Progress on using qualitative models, including development of the molecular collection ontology for reasoning about fluids, the interaction of qualitative and quantitative knowledge in analyzing thermodynamic cycles, and an experiment on building a natural language interface to qualitative reasoning is reported. Finally, some recommendations are made for future research. Author

**N90-23586*** National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
**INTERNAL WIRE GUIDE FOR GTAW WELDING Patent**
Gene E. Morgan, inventor (to NASA) and Gerald E. Dyer, inventor (to NASA) (Rockwell International Corp., Canoga Park, CA.) 7 Nov. 1989 5 p Filed 5 Dec. 1988 Supersedes N89-23739 (27 - 17, p 2420) Sponsored by NASA. Marshall Space Flight Center
(NASA-Case-MFS-29489-1; US-Patent-4,879,446; US-Patent-Appl-SN-279625; US-Patent-Class-219-75; US-Patent-Class-219-136; Int-Patent-Class-B23K-9/16) Avail: US Patent and Trademark Office CSCL 13H

A welding torch for gas tungsten arc welding apparatus has a filler metal wire guide positioned within the torch, and within the shielding gas nozzle. The wire guide is adjacent to the tungsten electrode and has a ceramic liner through which the wire is fed. This reduces the size of the torch and eliminates the outside clearance problems that exit with external wire guides. Additionally, since the wire is always within the shielding gas, oxidizing of the wire is eliminated.
Official Gazette of the U.S. Patent and Trademark Office

**N90-23587*** National Aeronautics and Space Administration. Pasadena Office, CA.
**CONVERGENT STRAND ARRAY LIQUID PUMPING SYSTEM Patent**
Earl R. Collins, Jr., inventor (to NASA) 31 Oct. 1989 9 p

Filed 13 Apr. 1989
(NASA-Case-NPO-17301-1-CU; US-Patent-4,877,082;
US-Patent-Appl-SN-337767; US-Patent-Class-165-104.26;
US-Patent-Class-165-41; US-Patent-Class-122-366;
US-Patent-Class-222-187; US-Patent-Class-239-145;
US-Patent-Class-417-53; US-Patent-Class-417-572) Avail: US Patent and Trademark Office CSCL 13H

A surface-tension liquid pumping system is provided by one or more arrays of converging solid monofilament fibers or metal wires (strands) spaced apart at an input end to gather liquid, and gathered close together at the opposite end where menisci forms between wetted strands to force liquid in the direction of convergence of the strands. The liquid pumping system is independent of gravity. It is illustrated as being used in a heat pump having a heating box to vaporize the liquid and a condensing chamber. Condensed liquid is returned by the pumping system to the heating box where it is again vaporized. A vapor tube carries the vapor to the condensing chamber. In that way, a closed system pumps heat from the heating box to the evaporating chamber and from there radiated to the atmosphere.

Official Gazette of the U.S. Patent and Trademark Office

**N90-23588#** Systems Engineering Labs., Inc., Greenbelt, MD.
**NONLINEAR DYNAMICS AND CONTROL OF FLEXIBLE STRUCTURES Annual Report, 1 Sep. 1987 - 31 Aug. 1988**
W. H. Bennett, H. G. Kwatny, G. L. Blakenship, and O. Akhrif 15 Nov. 1988 159 p
(Contract F49620-87-C-0103)
(AD-A218372; SEI-88-11-15-WB; AFOSR-90-0201TR) Avail: NTIS HC A08/MF A01 CSCL 13/2

The unprecedented requirements for rapid retargeting and precision pointing for spaced-based directed energy weapon platforms is the prime driver behind the reported modeling and control study. The combination of such requirements demand a comprehensive dynamic model of the nonlinear multibody dynamics of typical space platforms for such weapon including the interaction platform structural flexure effecting principal weapon system effective Line-Of-Sight. The first year effort of a three year project is described, which focuses on: the development of comprehensive; generic nonlinear dynamical models for typical space-based platforms; the development of high performance, nonlinear control laws for rapid slewing and precession pointing of primary weapon system payload apertures; and the design of a series of laboratory experiments to verify and test the control laws developed. The validation of the analytical models and the required control theory for the resulting class of nonlinear system is described. Simulation results are given for a simplified. Benchmark model of a space-based laser slewing control and consideration for compensation for structural flexure effecting optical LOS using optical steering mirrors is discussed. GRA

**N90-23589#** Techno-Sciences, Inc., Greenbelt, MD.
**NONLINEAR DYNAMICS AND CONTROL OF FLEXIBLE STRUCTURES Annual Report, Sep. 1988 - Aug. 1989**
W. H. Bennett, H. G. Kwatny, G. L. Blakenship, O. Akhrif, and C. LaVigna 12 Dec. 1989 128 p
(Contract F49620-87-C-0103; AF Proj. D812)
(AD-A218476; TSI-89-1212-WB; AFOSR-90-0200TR) Avail: NTIS HC A07/MF A01 CSCL 15/6

Basic performance requirements for space-based directed energy weapons involve unprecedented requirements for integrated control of rapid retargeting and precision pointing of space structures. Multibody interactions excite nonlinear couplings which complicate the dynamic response. Attempts to reduce flexure response for such weapon platforms by passive techniques alone may be inadequate due to stringent pointing requirements. The principal objective of the research program is the validation and testing of high precision, nonlinear control of multibody systems with significant structural flexure where interactions arise due to rapid slewing. Dominant nonlinear couplings effecting LOS response have been identified based on a comprehensive model of the nonlinear multibody dynamics of a generic space weapon. The innovative approach to LOS slewing/pointing developed in this study is based on implementation of decoupling (by feedback control) of the principal nonlinear dynamics and structural flexure response. In this study we have focused on the implementation of partial feedback linearization and decoupling and have identified practical conditions for its implementation. A principal contribution of the study is the reconciliation of design of discontinuous control via sliding mode control with partial feedback linearization for rapid slewing of system effective LOS. GRA

**N90-23590#** Aerospatiale, Paris (France).
**ESPRIT 820:QUIC. QUIC TOOLKIT DEMONSTRATOR APPLICATIONS**
A. Cavanna, J. C. Chautard, C. Honnorat, M. Levin, and B. Klausen (Smidth, F. L. and Co. A/S, Copenhagen, Denmark ) May 1989 27 p Sponsord by EEC
(Rept-892-440-105; CA-5/89; ETN-90-96662) Avail: NTIS HC A03/MF A01

The QUIC (Quality Industrial Control) toolkit can be characterized as an application environment specially designed to support process control applications. The QUIC toolkit methodology and terminology were validated on three different applications ranging from diagnosis of power plant condenser subsystems over monitoring and control of spacecrafts to control of vital parts in cement manufacturing plants. For each application a detailed system description is provided together with a task analysis which provide the mapping of the demonstrator requirements onto the QUIC toolkit. Using the methodology and terminology of the QUIC toolkit each application is hierarchically decomposed into its basic building blocks. Validation results are described and discussed. ESA

**N90-23591*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**INTRODUCING THE VRT GAS TURBINE COMBUSTOR**
Jerry O. Melconian, Abdu A. Mostafa (Textron Lycoming, Stratford, CT.), and Hung Lee Nguyen 1990 14 p Presented at the 26th Joint Propulsion Conference, Orlando, FL, 16-18 Jul. 1990; cosponsored by AIAA, SAE, ASME, and ASEE
(NASA-TM-103176; E-5554; NAS 1.15:103176; AIAA-90-2452)
Avail: NTIS HC A03/MF A01 CSCL 21E

An innovative annular combustor configuration is being developed for aircraft and other gas turbine engines. This design has the potential of permitting higher turbine inlet temperatures by reducing the pattern factor and providing a major reduction in NO(x) emission. The design concept is based on a Variable Residence Time (VRT) technique which allows large fuel particles adequate time to completely burn in the circumferentially mixed primary zone. High durability of the combustor is achieved by dual function use of the incoming air. The feasibility of the concept was demonstrated by water analogue tests and 3-D computer modeling. The computer model predicted a 50 percent reduction in pattern factor when compared to a state of the art conventional combustor. The VRT combustor uses only half the number of fuel nozzles of the conventional configuration. The results of the chemical kinetics model require further investigation, as the NO(x) predictions did not correlate with the available experimental and analytical data base. Author

# 32 COMMUNICATIONS AND RADAR

Includes radar; land and global communications; communications theory; and optical communications.

For related information see also *04 Aircraft Communications and Navigation* and *17 Space Communications, Spacecraft Communications, Command and Tracking.* For search and rescue see *03 Air Transportation and Safety,* and *16 Space Transportation.*

**N90-23592** British Broadcasting Corp., Kingswood (England). Engineering Div.
**BEAMFORMING DEVICES AND FEED STRUCTURES FOR A DBS FLAT-PLATE ANTENNA**

S. Wakeling 1989 16 p
(BBC-RD-1989/12; RA-255) Copyright Avail: BBC, Kingswood Warren, Tadworth, Surrey, England

A flat-plate antenna is considered to be a viable alternative to a parabolic dish for the reception of direct broadcast by satellite (DBS) television signals. A flat-plate antenna should form beams over a range of different directions, pointing at the satellite from different orientations on the ground. A beamforming device can produce several beams from a given array. A feed network is needed to collect all the signals from the array elements and input them to the beamforming network. The types of feed structure which could be used with the flat-plate antenna are considered and the design of a corporate feed structure is reported. A number of steering mechanisms and beamforming devices are examined. A microwave lens proved to be the only option which could form beams from such a large array and be constructed using low cost materials. The design, construction and testing of an experimental Rotman lens is reported. Author

**N90-23593*#** Ford Aerospace and Communications Corp., Palo Alto, CA. Space System Operations.
**NASA 60 GHz INTERSATELLITE COMMUNICATION LINK DEFINITION STUDY. ADDENDUM A: MIXED BASEBAND AND IF SIGNALS**
5 Sep. 1986 69 p
(Contract NAS5-28589)
(NASA-CR-186337; NAS 1.26:186337) Avail: NTIS HC A04/MF A01 CSCL 17B

As part of a definition study for a 60 GHz intersatellite communications link system (ICLS), baseline design concepts for a channelized crosslink were identified. The crosslink would allow communications between geostationary satellites of the planned Tracking and Data Acquisition System (TDAS) and would accommodate a mixture of frequency translation coherent links (bent pipe links) and baseband-in/baseband-out links (mod/demod links). A 60 GHz communication system was developed for sizing and analyzing the crosslink. For the coherent links this system translates incoming signals directly up to the 60 GHz band; trunks the signals across from one satellite to a second satellite at 60 GHz then down converts to the proper frequency for re-transmission from the second satellite without converting to any intermediate frequencies. For the baseband-in/baseband-out links the baseband data is modulated on to the 60 GHz carrier at the transmitting satellite and demodulated at the receiving satellite. The frequency plan, equipment diagrams, and link calculations are presented along with results from sizing and reliability analyses. M.G.

**N90-23594*#** Ford Aerospace and Communications Corp., Palo Alto, CA. Space System Operations.
**NASA 60 GHz INTERSATELLITE COMMUNICATION LINK DEFINITION STUDY. BASELINE DOCUMENT**
9 Sep. 1986 149 p
(Contract NAS5-28589)
(NASA-CR-186339; NAS 1.26:186339) Avail: NTIS HC A07/MF A01 CSCL 17B

The overall system and component concepts for a 60 GHz intersatellite communications link system (ICLS) are described. The ICLS was designed to augment the capabilities of the current Tracking and Data Relay Satellite System (TDRSS), providing a data rate capacity large enough to accommodate the expected rates for user satellites (USAT's) in the post-1995 timeframe. The use of 60 GHz for the anticipated successor to TDRSS, the Tracking and Data Acquisition System (TDAS), was selected because of current technology development that will enable multigigibit data rates. Additionally, the attenuation of the earth's atmosphere at 60 GHz means that there is virtually no possibility of terrestrially generated interference (intentional or accidental) or terrestrially based intercept. The ICLS includes the following functional areas: (1) the ICLS payload package on the GEO TDAS satellite that communicates simultaneously with up to five LEO USAT's; (2) the payload package on the USAT that communicates with the TDAS satellite; and (3) the crosslink payload package on the TDAS satellite that communicates with another TDAS satellite. Two methods of data relay on-board the TDAS spacecraft were addressed. One is a complete baseband system (demod and remod) with a bi-directional 2 Gbps data stream; the other is a channelized system wherein some of the channels are baseband and others are merely frequency translated before re-transmission. Descriptions of the TDAS antenna, transmitter, receiver, and mechanical designs are presented. M.G.

**N90-23595*#** Ford Aerospace and Communications Corp., Palo Alto, CA. Space System Operations.
**NASA 60 GHz INTERSATELLITE LINKS DEFINITION STUDY. FINAL REVIEW**
3 Jun. 1986 202 p
(Contract NAS5-28589)
(NASA-CR-186338; NAS 1.26:186338) Avail: NTIS HC A10/MF A02 CSCL 17B

Viewgraphs are presented which outline the overall system and component concepts for a 60 GHz intersatellite communications link system (ICLS). The ICLS was designed to augment the capabilities of the current Tracking and Data Relay Satellite System (TDRSS), providing a data rate capacity large enough to accommodate the expected rates for user satellites (USAT's) in the post-1995 timeframe. Two methods of data relay on-board the planned TDAS (Tracking and Data Acquisition) satellites are described. One is an all-baseband system with a bi-directional 2 Gbps data stream; the other is a channelized crosslink system wherein some of the channels are baseband and others are merely frequency translated before re-transmission. The general system and technology design drivers are outlined along with the acquisition architecture design. Descriptions of the TDAS antenna, transmitter, receiver, and mechanical hardware are presented. M.G.

**N90-23596#** General Atomic Co., San Diego, CA.
**PARASITIC COUPLING OF THE FRINGING FIELDS OF AN ION-BERNSTEIN WAVE ANTENNA**
S. C. Chiu, V. S. Chan, F. W. Perkins, and S. Puri (Max-Planck-Inst. fuer Plasmaphysik, Garching, Germany, F.R. ) Apr. 1990 6 p Presented at the 17th European Conference on Controlled Fusion and Plasma Heating, Amsterdam, Netherlands, 25-29 Jun. 1990
(Contract DE-AC03-89ER-53277)
(DE90-009918; GA-A-20031; CONF-900602-6) Avail: NTIS HC A02/MF A01

Ion-Bernstein wave (IBW) heating is an important method of heating a tokamak plasma. In past experiments, the loading of an IBW antenna is known to be considerably higher than that predicted by linear theory. It was attributed to background loading due to unknown mechanisms. Here, it is proposed that a possible mechanism is the coupling of the fringing fields of the Faraday screen to a short wavelength electrostatic mode. This mode is highly dissipative and can be propagative or evanescent, depending on the edge parameters. The problem is formulated as a mixed boundary value problem and solved by singular integral technique. Numerical results indicate that this can be significant parasitic coupling mechanism whose magnitude at typical edge parameters can be significantly larger than the coupling to the desired IBW. It is insensitive to variation in magnetic field, which is in sharp contrast to theoretical predictions for IBW coupling. The dependence of the coupling to plasma and antenna parameters will be presented. Relevance to experiments will be discussed. DOE

**N90-23597#** Office of Naval Research, Arlington, VA.
**NONLINEAR WAVES AND INVERSE SCATTERING Final Report**
M. J. Ablowitz 1989 7 p
(Contract N00014-88-K-0447)
(AD-A218483) Avail: NTIS HC A02/MF A01 CSCL 12/1

An understanding is sought for nonlinear phenomena arising in physical problems. The solution to a number of these problems involves the Inverse Scattering Transform (IST). This is a method which employs the inverse scattering theory in order to linearize the given nonlinear equations. IST has led to new developments in both fields: inverse scattering and nonlinear wave equations. The following topics are discussed: multidimensional nonlinear

evolution equations and inverse scattering; semi-infinite and forced nonlinear equations; numerically induced chaos; and cellular automata and solitons. Author

**N90-23598#** Naval Ocean Systems Center, San Diego, CA.
**PROCEEDINGS OF THE 12TH SYMPOSIUM ON SIGNAL AND IMAGE PROCESSING ENGLISH-LANGUAGE ABSTRACTS**
Dec. 1989 193 p Symposium held in Juan Les-Pins, France, 12-16 Jun. 1989
(AD-A218806; NOSC/TD-1661) Avail: NTIS HC A09/MF A01 CSCL 20/1

This symposium, sponsored by the Groupe de Recherche et d'Etudes du Traitement du Signal (Signal Processing Research Association), known as GRETSI, is held biennially in the spring, and for many years has been the foremost showplace for French work in all areas of signal-processing research, and particularly in underwater acoustics. Topics addressed: signal theory; digital processing; detection-estimation; spectral analysis; communications; adaptive systems; sonar-radar; speech; segmentation and pattern recognition; motion analysis in an image sequence; image restoration and reconstruction; image coding and compression; and biomedical applications. GRA

**N90-23599#** Pennsylvania Univ., Philadelphia. Dept. of Electrical Engineering.
**RESEARCH ON STATISTICAL TECHNIQUES FOR SIGNAL PROCESSING Final Technical Report, 1 Nov. 1986 - 31 Oct. 1989**
Saleem A. Kassam 1 Feb. 1990 9 p
(Grant AF-AFOSR-0052-87; AF Proj. 2304)
(AD-A218811; AFOSR-90-0264TR) Avail: NTIS HC A02/MF A01 CSCL 12/3

The primary accomplishments of this grant were in the areas of: signal detection in non-Gaussian noise, including nonparametric and robust detection; nonlinear edge-preserving filtering of signals in impulsive noise, based on robust estimation procedures; and applications in constant false alarm rate radar detection and image processing. Reference is made to 27 publications. GRA

**N90-23600#** Carnegie-Mellon Univ., Pittsburgh, PA.
**DEVELOPMENT OF NEW METHODS FOR PREDICTING THE BISTATIC ELECTROMAGNETIC SCATTERING FROM ABSORBING SHAPES Final Report, Sep. 1983 - Apr. 1986**
Z. J. Cendes, D. Hudak, J. F. Lee, and D. Q. Sun Jan. 1990 190 p
(Contract F19628-83-C-0079; AF Proj. 2305)
(AD-A219327; RADC-TR-89-323) Avail: NTIS HC A09/MF A01 CSCL 20/14

More accurate, reliable and efficient methods to calculate the bistatic scattering of electromagnetic fields from absorbing dielectric fields from absorbing dielectric objects were developed. While solution of 3-D scattering problems has not been achieved, the methods developed provide, for the first time, finite element solutions of closed 3-D electromagnetic fields free of the spurious solutions that have plagued previous procedures. These stable finite elements are defined in three varieties: (1) mixed-order rectangular parallelepiped elements, (2) edge-based tangential vector finite elements, and (3) derivative continuous elements. Each is shown to give only physically correct solutions. A new procedure, called the transfinite element method, is also presented for solution of open or unbounded electromagnetic scattering problems. This method provides a one step procedure to compute scattered fields in electromagnetics. The transfinite element method is applied only in 2-D. Finally, a new high efficiency algorithm is proposed to compute electromagnetic scattering over a specified frequency range. In this algorithm, frequencies are selected adaptively to ensure a given accuracy in minimum computation time for the specified frequency range. The individual procedures are illustrated with a variety of examples. GRA

**N90-23601#** PCO, Inc., Chatsworth, CA.
**SINGLE MODE COMMUNICATION LINK Final Technical Report, Feb. 1986 - Nov. 1988**
Stephen R. Cole, D. C. Reid, and R. Carpenter Feb. 1990 48 p
(Contract F30602-86-C-0034)
(AD-A219499; RADC-TR-90-29) Avail: NTIS HC A03/MF A01 CSCL 25/5

Optical fiber transmission has many features which make it very attractive for military applications. Furthermore, single mode fiber is superior to multimode fiber in terms of bandwidth, attenuation, radiation resistance and cost. The benefits of single mode optical fiber transmission can be further enhanced with the use of wavelength division multiplexing (WDM) technology in which multiple, independent optical signals may be simultaneously transmitted over a single fiber. This permits single fiber transmission of mixed signal traffic (e.g., digital data, voice, video, analog, etc.) as well as parallel digital traffic characteristic of computer data transfer. In addition, this technology creates new system design options and architectural flexibility for local area networks (LANs). This technical report describes the design and development of the critical element for implementing such a communications link - a 16 channel single mode WDM. Specifically, it describes the development and performance of a grating-based single mode WDM system suitable for use with single longitudinal lasers (e.g., distributed feedback lasers (DFB's)). The 16 channel WDM features channels with 3 dB bandwidths of 2.4 nM and separation of 7.2 nM. Any particular channel can be set to a precise wavelength due to the mechanical design features. End-to-End system channel insertion losses of 12.5 dB have been achieved with adjacent channel crosstalk of better than -25 dB. GRA

**N90-23602#** Naval Postgraduate Scho l, Monterey, CA. Dept. of Administrative Sciences.
**JOINT TACTICAL ANTI-JAM COMMUNICATIONS: A SYSTEMS APPROACH M.S. Thesis**
Vasilios Christos Kavvadias Sep. 1989 185 p
(AD-A219592) Avail: NTIS HC A09/MF A01 CSCL 25/5

The conceptual design of a joint tactical anti-jam communication link from a systems point of view is analyzed. The requirements and the specifications for a communication system providing an integrated solution for Navies operating in closed sea areas under intense enemy jamming activity are addressed. The concept of the proposed system is based on spread spectrum technology and on the Joint Tactical Information Distribution System (JTIDS). Spread spectrum technology has been an area of extensive research for many years. Satisfactory practical solutions have been provided through the implementation of several frequency hopping systems that give partial answer to the anti-jam (AJ) problem. JTIDS is the only hybrid spread spectrum system intended to provide a catholic answer. The AJ performance of the proposed system is examined theoretically under realistic scenarios. System feasibility, from the overall cost standpoint, is evaluated using life cycle costing and sensitivity analysis. The trade-off between the procurement of an original system and a JTIDS-based design is also evaluated, based on the possible research costs. It is assumed that acquisition or procurement of such a system is not limited by any technology transfer barriers. GRA

**N90-23603#** BBN Systems and Technologies Corp., Cambridge, MA.
**UNFAIRNESS CAUSED BY QUADRATIC BACKOFF IN A PACKET-RADIO NETWORK**
Melisse Leib 19 Oct. 1989 14 p
(Contract MDA903-83-C-0131)
(AD-A219635; BBN-7174) Avail: NTIS HC A02/MF A01 CSCL 25/2

This note contains the performance analysis of a prototype packet-radio pacing algorithm designed to prevent congestion by throttling traffic sources. In the pacing algorithm, each packet radio measures data-packet forwarding times on a neighbor-by-neighbor basis, and scales them to compute a lower bound on packet inter-transmission times, known as a pacing delay. The scale factor is chosen to prevent packet radios from sending data packets to their neighbors faster than they can forward them. In summary, the pacing algorithm applies flow control to prevent congestion.

The prototype algorithm differentiates between packet transmissions at the head of a route and packet transmissions along a route. The pacing delays for the former case are scaled quadratically whereas the pacing delays for the latter case are scaled linearly. The objective is to prevent congestion by metering data packets into the network slower than they can traverse it. This source-throttling technique is called quadratic backoff. A mathematical model was derived for pacing-delay computations in a packet-radio network that demonstrates quadratic backoff introduces unfair stable equilibrium points. In other words, quadratic backoff causes a persistent situation to occur in which some routes get more bandwidth than others. GRA

**N90-23604#** BBN Systems and Technologies Corp., Cambridge, MA.
**DETECTING BLACK HOLES IN PACKET-RADIO NETWORKS (SRNTN-56)**
James Ong 1989 15 p
(Contract MDA903-83-C-0131)
(AD-A219636; BBN-7176) Avail: NTIS HC A02/MF A01 CSCL 25/2

Black holes can occur in packet-switched networks that use distance-vector route calculation algorithms such as tier routing. This section briefly reviews tier routing and defines new terms relevant to black holes. Packet radios use tier routing, a variation on distance-vector routing, to maintain routes to all radios in a non-hierarchical network or to all radios in the same cluster in a hierarchical network. Each radio's routing table contains an entry for each destination packet radio; the entry contains the following information: The destination packet radio ID, The reporting packet radio ID, and Hop count to the destination. Each packet radio periodically broadcasts a Packet Radio Organization Packet (PROP) to all of its neighbor radios, listing its distance to every destination as stored in its routing table. Neighbor packet radios update their routing tables to incorporate shorter routes described within this PROP. GRA

**N90-23605#** Minnesota Mining and Mfg. Co., Saint Paul.
**ARTIFICIAL DIELECTRICS Final Report**
12 Mar. 1990 3 p
(AD-A219671) Avail: NTIS HC A01/MF A01 CSCL 20/3

A literature search was performed to determine the state-of-the-art in modeling the electromagnetic wave reflection and transmission of periodic arrays of metallic and resistive patches in multilayer structures. The list of reference is attached. A preferred computational method was selected that could be implemented within the resource constraints of this contract. Satisfactory implementation of the algorithm was not completed before the work was stopped. GRA

**N90-23606#** Army Armament Research, Development and Engineering Center, Picatinny Arsenal, NJ. Fire Support Armament Center.
**A NEURAL NETWORK BASED SPEECH RECOGNITION SYSTEM Final Report, Jun. 1989 - Sep. 1989**
Edward J. Carroll, Norman P. Coleman, Jr., and G. N. Reddy Feb. 1990 15 p
(AD-A219794; ARFSD-TR-89014) Avail: NTIS HC A03/MF A01 CSCL 12/9

An overview is presented of the development of a neural network based speech recognition system. The two primary tasks involved were the development of a time invariant speech encoder and a pattern recognizer or detector. The speech encoder uses amplitude normalization and a Fast Fourier Transform to eliminate amplitude and frequency shifts of acoustic clues. The detector consists of a back-propagation network which accepts data from the encoder and identifies individual words. This use of neural networks offers two advantages over conventional algorithmic detectors: the detection time is no more than a few network time constants, and its recognition speed is independent of the number of the words in the vocabulary. The completed system has functioned as expected with high tolerance to input variation and with error rates comparable to a commercial system when used in a noisy environment. GRA

**N90-23607#** Royal Signals and Radar Establishment, Malvern (England).
**OBJECT ORIENTATED SIMULATION ON TRANSPUTER ARRAYS USING TIME WARP Memorandum Report**
P. Simpson Dec. 1989 63 p
(AD-A219795; RSRE-Memo-4334; DRIC-BR-112707) Avail: NTIS HC A04/MF A01 CSCL 12/7

The successful application of transputers to distributed event driven heterogeneous simulation using the time warp methodology is demonstrated with transputers and occam providing a natural vehicle for this class of simulation. The simulation technique basically comprises a number of communicating simulation object processes, with appropriate action being taken to ensure the correct chronological sequence of processed simulation events. Time warp is particularly attractive, since it permits all parts of a distributed processor network to operate in parallel (although some of the computation may later be undone). The need for hardware control of memory management has not been identified, although the requirement for a deadlock free, random point to point communications strategy has. GRA

**N90-23608#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**MEASUREMENT AND ANALYSIS OF THE ELECTROMAGNETIC SCATTERING OF A GEODESIC ARRAY OF TRIANGULAR TRIHEDRAL CORNER REFLECTORS M.S. Thesis**
Richard E. Hamilton Mar. 1990 240 p
(AD-A220457; AFIT/GE/ENG/90M-3) Avail: NTIS HC A11/MF A02 CSCL 17/4

This thesis investigated the EM scattering of a geodesic array consisting of a cluster of 20 trihedral corner reflectors held together by hinges. This target was designed to provide a large radar return with a spatial coverage greater than that due to an array of 8 corner reflectors. RCS, or echo area, was chosen as a means of investigating the EM scattering of a scaled model version of geodesic array. The RCS of the individual components of the geodesic array (i.e., the single corner reflectors) and the RCS of the geodesic array were measured using a continuous wave measurement technique. For the purpose of comparison, the RCS of an 8 corner reflector array was also measured. In order to gather as much spatial scattering information as possible, a unique target support mount was designed, constructed, and used to collect conical cut RCS patterns. Measured RCS patterns of the targets are included in the appendixes. A comparative analysis between the measured RCS of the geodesic array and that of the 8 corner reflector array was performed to determine how well the geodesic array met its designed goal. It was found that in almost all cases, the measured spatial RCS coverage for the geodesic array was equal to or better than the measured spatial RCS coverage of the array of 8 corner reflectors. The only exception was for broadside incidence for which the geodesic array spatial coverage was slightly less. GRA

**N90-23609#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**THROUGHPUT AND DELAY CHARACTERISTICS FOR A SLOW-FREQUENCY HOPPED AIRCRAFT-TO-AIRCRAFT PACKET RADIO NETWORK M.S. Thesis**
Scott Russell Harrison Mar. 1990 123 p
(AD-A220525; AFIT/GCS/ENG/90M-01) Avail: NTIS HC A06/MF A01 CSCL 25/2

Current lack of data transfer capability between tactical aircraft results in decreased mission effectiveness or the need to equip every aircraft with all the sensors and data processing equipment to perform each task expected of them. In the Air Force, these developments established the need for aircraft-to-aircraft data communications so that navigation, threat and targeting information could be shared within a flight and so that digital voice communications could also be maintained. Data rates within a

flight of fighter aircraft to support these requirements will need to be between 100 and 250 kilobits/second (KBPS) and between 2.4 KBPS and 16 KBPS between the flight and a command and control aircraft. Other sources place the former figure as high as 512 KBPS. To increase the security of these radio channels, against both jamming and intrusion, anti-jam and low probability of interception (LPI) techniques must be used. One method of achieving these capabilities is to use spread spectrum techniques such as frequency hopping. The Air Force is currently concentrating its efforts around the Joint Tactical Information Distribution System (JTIDS). GRA

**N90-23610#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

**FREQUENCY ASSIGNMENTS FOR HFDF RECEIVERS IN A SEARCH AND RESCUE NETWORK M.S. Thesis**

Krista E. Johnson Mar. 1990 88 p

(AD-A220529; AFIT/GOR/ENS/90M-9) Avail: NTIS HC A05/MF A01 CSCL 25/2

This thesis applies a multiobjective linear programming approach to the problem of assigning frequencies to high frequency direction finding (HFDF) receivers in a search-and-rescue network in order to maximize the expected number of geolocations of vessels in distress. The problem is formulated as a multiobjective integer linear programming problem. The integrality of the solutions is guaranteed by the totally unimodularity of the A-matrix. Two approaches are taken to solve the multiobjective linear programming problem: (1) the multiobjective simplex method as implemented in ADBASE; and (2) an iterative approach. In this approach, the individual objective functions are weighted and combined in a single additive objective function. The resulting single objective problem is expressed as a network programming problem and solved using SAS NETFLOW. The process is then repeated with different weightings for the objective functions. The solutions obtained from the multiobjective linear programs are evaluated using a FORTRAN program to determine which solution provides the greatest expected number of geolocations. This solution is then compared to the sample mean and standard deviation for the expected number of geolocations resulting from 10,000 random frequency assignments for the network. GRA

**N90-23611#** Army War Coll., Carlisle Barracks, PA.

**MARITIME SAFETY INFORMATION IN THE YEAR 2000: LISTEN UP, NAVY, THE TIMES THEY ARE A CHANGIN' Study Project**

Steven C. Hall 2 Apr. 1990 53 p

(AD-A220563) Avail: NTIS HC A04/MF A01 CSCL 17/7

Maritime safety information is that special category of navigational safety data that warns mariners at sea of hazards to navigation which might encountered while underway. It does the most good when received before the hazard is encountered. The U.S. Navy pioneered the use of radio to transmit maritime safety information to ships at sea beginning in 1908. Over the years, they have relinquished this position as a leader and become a follower. Beginning in 1992, the commercial maritime world will step out ahead of the U.S. Navy using modern commercial communications technology. Unless Navy reconsiders its position on receiving maritime safety information using NAVTEX and SafetyNET, it will remain a follower and be seriously disadvantaged. The risk here is not in losing a race, but in losing a ship. GRA

**N90-23612#** Electromagnetic Compatibility Analysis Center, Annapolis, MD.

**AN ANALYSIS OF PROPAGATION IN A SURFACE DUCT OVER A PERIODICALLY ROUGH EARTH**

Sherman W. Marcus and Michael L. Haberman Feb. 1990 80 p Sponsored in part by IIT Research Inst., Annapolis, MD

(Contract F19628-85-C-0071; AF Proj. 0813)

(AD-A220565; ECAC-TR-88-001) Avail: NTIS HC A05/MF A01 CSCL 20/14

A mathematical model for determining the effects of a small sinusoidal roughness on horizontally polarized radio waves, propagating over large distances in a horizontally homogenous tropospheric duct, is presented. The wave equation is solved for the appropriate boundary conditions. The eigenvalues of the solution are the roots of an infinite determinant. An effective reflection coefficient is derived used with the infinite determinant to obtain an equivalent zero mode matrix, from which the eigenvalues can be obtained. A perturbation method is then used to derive a computationally efficient means of calculating the eigenvalues from the equivalent matrix. Examples that demonstrate that the attenuation due to the roughness can be significant are provided. GRA

**N90-23613#** Massachusetts Inst. of Tech., Lexington. Lincoln Lab.

**LOW-SIDELOBE PHASED ARRAY ANTENNA CHARACTERISTICS USING THE PLANAR NEAR-FIELD SCANNING TECHNIQUE: THEORY AND EXPERIMENT**

A. J. Fenn, H. M. Aumann, and F. G. Willwerth 14 Feb. 1990 47 p

(Contract F19628-90-C-0002)

(AD-A220611; TR-870; ESD-TR-89-235) Avail: NTIS HC A03/MF A01 CSCL 20/14

Characteristics of a low-sidelobe phased array antenna are investigated using the technique of planar near-field scanning. The theory associated with the planar near-field scanning technique, with and without probe compensation, is reviewed and an application of the theory is made. The design of an experimental low-sidelobe phased array antenna consisting of monopole elements which are corporate-fed using high precision transmit/receive modules is described. Accurate array radiation patterns are obtained both theoretically and experimentally using centerline scanning at less than one wavelength distance from the antenna. The effects of the antenna probe on the array near-field pattern, plane-wave spectrum, and far-field pattern are demonstrated theoretically using a method of moments numerical simulation. Comparisons of the array theoretical near-zone electric field and array received voltage due to a V-dipole near-field transmitting probe are made. It is shown that a V-dipole theoretical probe antenna can accurately model a practical near-field measurement probe consisting of an open-ended rectangular waveguide surrounded with anechoic material. GRA

**N90-23614#** Naval Research Lab., Washington, DC. Beam Physics Branch.

**CRITIQUE OF NONDIFFRACTING BEAMS Interim Report**

P. Sprangle and B. Hafizi (Science Applications International Corp., McLean, VA.) 3 Apr. 1990 20 p Sponsored by ONR, Arlington, VA

(AD-A220722; NRL-MR-6615) Avail: NTIS HC A03/MF A01 CSCL 20/14

A number of researchers have discussed the possibility of generating electromagnetic beams or pulses which can propagate without the usual degree of transverse spreading. Nondiffracting directed radiation beams have been the subject of a number of special sessions at various conferences. Our intention in this note is to discuss: (1) the Bessel beam which has been called remarkably resistant to the diffractive spreading commonly associated with all wave propagation; and (2) the electromagnetic directed energy pulse train which is claimed to be significantly improved over conventional, diffraction-limited beams, and to defeat diffraction. This note shows that diffraction is not eliminated or reduced in any of the proposed schemes and that conventional Gaussian beams will propagate at least as far for a given transmitting antenna dimension. GRA

**N90-23615#** Defence Research Establishment, Ottawa (Ontario). Airborne Radar Section.

**A THEORETICAL MODEL FOR AIRBORNE RADARS**

D. Faubert Nov. 1989 67 p

(AD-A220735; DREO-1017) Avail: NTIS HC A04/MF A01 CSCL 17/9

This work describes a general theory for the simulation of airborne (or spaceborne) radars. It can simulate many types of systems including Airborne Intercept and Airborne Early Warning

radars, airborne missile approach warning systems etc. It computes the average Signal-to-Noise ratio at the output of the signal processor. In this manner, one obtains the average performance of the radar without having to use Monte Carlo techniques. The model has provision for a waveform without frequency modulation and one with linear frequency modulation. The waveform may also have frequency hopping for Electronic Counter Measures or for clutter suppression. The model can accommodate any type of encounter including air-to-air, air-to-ground (look-down) and rear attacks. It can simulate systems with multiple phase centers on receive for studying advanced clutter or jamming interference suppression techniques. An Airborne Intercept radar is investigated to demonstrate the validity and the capability of the model. GRA

**N90-23616#** Naval Ocean Systems Center, San Diego, CA.
**ENGINEER'S REFRACTIVE EFFECTS PREDICTION SYSTEM (EREPS), REVISION 2.0 Interim Report**
W. L. Patterson, C. P. Hattan, H. V. Hitney, R. A. Paulus, A. E. Barrios, G. E. Lindem, and K. D. Anderson Feb. 1990 201 p Revised Sponsored by Office of Naval Technology, Arlington, VA
(AD-A220742; NOSC/TN-1342-Rev-2.0) Avail: NTIS HC A10/MF A02 CSCL 20/14

The Engineer's Refractive Effects Prediction System (EREPS) is a system of individual stand-alone IBM/PC-compatible programs that have been designed to assist an engineer in properly assessing electromagnetic propagation effects of the lower atmosphere on proposed radar, electronic warfare, or communication systems. The EREPS models account for effects from optical interference, diffraction, tropospheric scatter, refraction, evaporation and surface-based ducting, and water-vapor absorption under horizontally homogeneous atmospheric conditions. EREPS revision 2.0 is an upgrade to revision 1.0 released in July 1988 (Hitney, 1988). There are two completely new programs in revision 2.0, COVER and PROPH, and a user-callable propagation-factor source code subroutine that may be helpful to anyone who wants to integrate the EREPS propagation model into their own applications program. GRA

**N90-23617#** Michigan Univ., Ann Arbor. Radiation Lab.
**MILLIMETER - WAVE RADAR SCATTERING FROM TERRAIN: DATA HANDBOOK Technical Report, Oct. 1989 - Jan. 1990**
Thomas F. Haddock and Fawwaz T. Ulaby 30 Jan. 1990 133 p
(Contract DAAL03-89-K-0056)
(AD-A220770; Rept-026247-1-T; ARO-26224.1-GS) Avail: NTIS HC A07/MF A01 CSCL 17/9

This report provides a summary of experimental observations of the radar backscatter from terrain, measured by the University of Michigan truck-mounted radar. The data is at 35, 94, and 140 GHz at HH, VV, and HV polarizations. The terrain types observed include dry and wet snow, in covered ground, trees, grasses, asphalt, and gravel. GRA

**N90-23618#** Los Alamos National Lab., NM. Life Sciences Div.
**LACK OF BEHAVIORAL EFFECTS OF HIGH-PEAK-POWER MICROWAVE PULSES FROM AN AXIALLY EXTRACTED VIRTUAL CATHODE OSCILLATOR Final Report, Mar. - Sep. 1988**
Dennis L. Hjeresen, Kathryn O. Umbarger, B. Jon Klauenberg, and David N. Erwin Nov. 1989 31 p
(AF Proj. 7757)
(AD-A220779; USAFSAM-TR-89-24) Avail: NTIS HC A03/MF A01 CSCL 06/7

The development of high-power microwave (HPM) generators capable of producing extremely high-peak-power pulses for defense, commercial, and biomedical applications (1,2) has raised concern for the safety of the personnel operating such equipment. Occupational safety standards for radiofrequency exposure are based on the average-power density of irradiation and may lack applicability in situations where peak-power density is quite high while average-power density is relatively low. A battery of behavioral experiments was conducted to evaluate possible biological effects of high-power microwave (HPM) pulses generated by the Transformer Energized Megavolt Pulsed Output (TEMPO) microwave emitter, an axially extracted Virtual Cathode Oscillator (VIRCATOR). Free space electromagnetic energy in the frequency range 2.01 to 2.57 GHz (mean frequency = 2.11 + or - 0.09 SD) was radiated by conical horn in a TM01 mode. The overall pulse width was approximately 85 ns, with maximum power densities ranging as high as 24.11 kW/cm sq. per pulse (mean peak-power density = 10.79 kW/cm sq. + or - 0.35 SEM). The results suggest that peak power is not as important as average power in causing deleterious biological effects. GRA

**N90-23619#** Naval Research Lab., Washington, DC. Beam Physics Branch.
**DIFFRACTION EFFECTS IN DIRECTED RADIATION BEAMS Interim Report**
B. Hafizi (Science Applications International Corp., McLean, VA.) and P. Sprangle 3 Apr. 1990 59 p
(Contract DE-AI05-83ER-40117)
(AD-A220785; NRL-MR-6609) Avail: NTIS HC A04/MF A01 CSCL 20/14

A number of proposed applications of electromagnetic waves require that the radiation beam maintain a high intensity over an appreciable propagation distance. These applications include, among others, power beaming, advanced radar, laser acceleration of particles and directed-energy sources. The quest to achieve these objectives has led to a resurgence of research on diffraction theory. This report presents a survey and critique of the analyses and experimental tests of solutions of the wave equation in connection with so-called diffractionless and other directed radiation beams. The examples discussed in this paper include electromagnetic missiles, Bessel beams, electromagnetic directed energy pulse trains, and electromagnetic bullets. GRA

**N90-23620#** Washington Univ., Saint Louis, MO. Electronic Systems and Signals Research Lab.
**HIGH-RESOLUTION RADAR IMAGING Report, 15 Jan. 1989 - 14 Jan. 1990**
Donald L. Snyder 14 Jan. 1990 77 p
(Contract N00014-86-K-0370)
(AD-A220809) Avail: NTIS HC A05/MF A01 CSCL 17/9

The goal of this project is to formulate and investigate new approaches for forming images of radar targets from spotlight-mode, delay-Doppler measurements. These measurements can be acquired with a high-resolution radar-imaging operating with an optical- or radio-frequency carrier. Work in this reporting period has concentrated on our estimation-theory approach to forming high resolution images. This approach accounts for measurement noise and for the statistical properties of radar-backscatter data. GRA

**N90-23621#** Defence Research Establishment, Ottawa (Ontario).
**TEMPORAL STATISTICS OF LOW-ANGLE GROUND CLUTTER**
H. C. Chan Dec. 1989 44 p
(AD-A220816; DREO-1021) Avail: NTIS HC A03/MF A01 CSCL 17/9

Detailed knowledge of the temporal statistics of ground clutter is essential to determine the detection threshold settings so as to maximize the probability of target detection while maintaining an acceptable probability of false alarm. The performance of existing false alarm control schemes is often limited due to a lack of detailed knowledge of the ground clutter temporal statistics. In this study we analyze experimental data to characterize the temporal statistics of low-angle ground clutter in terms of the clutter's linear amplitude distribution. Effects of radar frequency, polarization, waveform resolution, land covers and wind speed on the statistics are examined. Results show that the Ricean distribution and its limiting case, the Rayleigh distribution, are appropriate models for ground clutter in steady-state wind conditions. This implies that the diffuse clutter components, which give rise to the random properties of ground clutter may be modeled as a complex Gaussian process. At any given time there is a

fraction of the resolution cells with clutter data having nonstationary temporal statistics not well modelled by the Ricean or Rayleigh distribution. The frequency of occurrence of nonstationary clutter statistics depends on radar frequency, land cover and wind speed. Forested land cover represents the worst case scenario. Application of the results of this study to determine optimal detection threshold settings is discussed. GRA

**N90-23622#** Defence Research Establishment, Ottawa (Ontario).
**SPECTRAL CHARACTERISTICS OF LOW-ANGLE RADAR GROUND CLUTTER**
H. C. Chan Dec. 1989 48 p
(AD-A220817; DREO-1020) Avail: NTIS HC A03/MF A01 CSCL 17/9

A detailed analysis of low-angle ground clutter spectral characteristics was carried out using the MIT Lincoln Lab Phase 1 data and the DREO S-band clutter data. Both the fast Fourier transform and a super-resolution spectral analysis technique were used. Results showed that a ground clutter spectrum comprises three components, namely: (1) a coherent component; (2) a slow-diffuse component; and (3) a fast-diffuse component. Both the coherent component and the slow-diffuse component may be modelled as a symmetrical negative exponential density function. The fast-diffuse component may be modelled as a band-limited noise. Model parameters included the spectral slopes, the spectral density at zero-Doppler, and the cutoff frequency of the fast-diffuse component. The spectral slopes of the slow-diffuse component at various wind speeds have been calculated from the clutter data. The spectral densities of the various components were inter-related through wind speed and land cover. These parameters can be determined statistically from the clutter coherence factor for various land covers and wind speeds. Results of this analysis provided additional insights into ground clutter and can be used to develop signal processing techniques for improved low-velocity target detection in ground-clutter limited environment. GRA

**N90-23623** Institut d'Aeronomie Spatiale de Belgique, Brussels.
**ELECTRIC DIPOLE ANTENNAE USED AS MICROMETEOROID DETECTORS**
J. M. Lesceux, J. Lemaire, and N. Meyer-Vernet (Observatoire de Paris-Meudon, France ) 1989 23 p Previously announced in IAA as A90-15094 Submitted for publication
(Aeronomica-Acta-A-351-1989; ISSN-0065-3713; ETN-90-96572) Avail: Inst. d'Aeronomie Spatiale de Belgique, 3 Avenue Circulaire, B-1180 Brussels, Belgium

The possibilities of using electric antennae made of two small spheres to detect charged dust grains in space are examined. The electric potential difference between the two spheres is determined from Poisson's equation in a plasma and several examples of waveforms are shown as illustration. For dust grains of radius of 100 microns, signals of the order of 500 microvolts are produced. The limitations due to the antenna shot noise and to the plasma thermal noise are examined. A table summarizes the results in different conditions. With a system of antennae, it is shown possible to detect (especially near comets and planetary ionospheres) dusts, with a view to determining their velocity characteristics. ESA

**N90-23624#** Aerospatiale, Cannes (France).
**LAND MOBILE COMMUNICATIONS FROM NON GEOSTATIONARY ORBITS (REVIEW OF ARCHIMEDES ESA STUDY)**
F. Giovagnoli Apr. 1989 25 p
(Rept-892-440-100, CA-4799; ETN-90-96663) Avail: NTIS HC A03/MF A01

Goals considered in the study are summarized in terms of parameters (coverage, services, link performances, frequency band) and requirements. Molniya and tundra orbits are discussed. Work performed in the Archimedes ESA study included: mission, orbits and launch strategies analyses; telecommunication system definition; satellite payload and platform design; ground segment investigations (user terminal, fixed Earth stations; mission control station); economic viability. ESA

**N90-23625#** Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany, F.R.). Space Systems Group.
**APPLICABILITY OF ASYNCHRONOUS TRANSFER MODE (ATM) TECHNIQUES TO SATELLITE COMMUNICATIONS SYSTEMS**
H. Kuhlen, G. Hertel, A. Vernucci, F. Delli-Priscoli, M. Moerzinger, A. Zambra, M. Merri, A. Roveri, and O. Millies-Lacroix (European Space Agency, Paris, France ) 1989 9 p Presented at the 8th International Conference on Digital Satellite Communications, Pointe-a-Pitre, Guadeloupe, 24-27 Apr. 1989
(Contract ESA-7300/87/F/RD(SC))
(MBB-UK-0059-89-Pub; ETN-90-96777) Avail: NTIS HC A02/MF A01

The general applicability of Asynchronous Transfer mode (ATM) techniques to future communications satellite systems is investigated. More precisely the applicability is discussed in three distinct scenarios, a network, a user, and a data relay, satellite oriented scenario. The complexity and the resulting technological implications of the satellite based switch configurations and the associated ground network interfaces are presented. Trends in the evolution of technologies for high-speed, large scale integration devices and their feasibility for space switches are discussed. ESA

**N90-23626#** British Aerospace Public Ltd. Co., Preston (England).
**A MODEL OF ELECTROMAGNETIC LEAKAGE THROUGH JOINTS AT RADIO FREQUENCIES**
P. D. Andrew 25 Dec. 1989 22 p
(BAe-WES-RP-GEN-EMC-049-T2.2; ETN-90-96785) Copyright Avail: NTIS HC A03/MF A01

Mathematical details of a proposed model to predict the effects of joints and seams in structures undergoing electromagnetic irradiation at very high frequencies are presented. The model consists of representing a joint or seam as a radiating magnetic dipole. Both Cartesian and spherical polar coordinates are used and are shown to produce identical results. The applicability of the model and details of further work are also included. ESA

**N90-23627#** Naval Postgraduate School, Monterey, CA.
**COMPUTER-AIDED MATHEMATICAL ANALYSIS OF PROBABILITY OF INTERCEPT FOR GROUND-BASED COMMUNICATION INTERCEPT SYSTEM M.S. Thesis**
Sang Chul Park Sep. 1989 100 p
(AD-A219856) Avail: NTIS HC A05/MF A01 CSCL 17/4

We develop a mathematical analysis model to calculate the probability of intercept (POI) for the ground-based communication intercept (COMINT) system. The POI is a measure of the effectiveness of the intercept system. We define the POI as the product of the probability of detection and the probability of coincidence. The probability of detection is a measure of the receiver's capability to detect a signal in the presence of noise. The probability of coincidence is the probability that an intercept system is available, actively listening in the proper frequency band, in the right direction and at the same time that the signal is received. We investigate the behavior of the POI with respect to the observation time, the separation distance, antenna elevations, the frequency of the signal, and the receiver bandwidths. We observe that the coincidence characteristic between the receiver scanning parameters and the signal parameters is the key factor to determine the time to obtain a given POI. This model can be used to find the optimal parameter combination to maximize the POI in a given scenario. We expand this model to a multiple system. This analysis is conducted on a personal computer to provide the portability. The model is also flexible and can be easily implemented under different situations. GRA

**N90-23628#** Georgia Inst. of Tech., Atlanta. Dept. of Electrical Engineering.
**MESSAGE HANDLING IN THE POST-2000 ERA: EXECUTIVE SUMMARY Final Report, 15 Feb. - 30 Nov. 1989**
Douglas W. Browing and Stephen B. Wicker 17 Nov. 1989 15 p
(Contract DAKF11-86-D-0015)
(AD-A219983; ASQB-CG-90-013) Avail: NTIS HC A03/MF A01 CSCL 25/2

Communication architecture for message handling in the very far-term heavy tactical environment are considered. The projected limitations of technology, a taxonomy of possible architectures, and projected requirements are presented. Based on this information, the suitability of architectural options is analyzed, and an architecture is proposed for post-2000 mobile and nonmobile tactical communications. The implications for standards are discussed. GRA

**N90-23629#** Naval Postgraduate School, Monterey, CA.
**OPTIMIZING ECM TECHNIQUES AGAINST MONOPULSE ACQUISITION AND TRACKING RADARS M.S. Thesis**
Ki Hoon Kwon Sep. 1989 72 p
(AD-A220036) Avail: NTIS HC A04/MF A01 CSCL 17/4

Electronic countermeasure (ECM) techniques against monopulse radars, which are generally employed in the Surface-to-Air Missile targeting system, are presented and analyzed. Particularly, these ECM techniques are classified into five different categories, which are; denial jamming, deception jamming, passive countermeasures, decoys, and destructive countermeasures. The techniques are fully discussed. It was found difficult to quantize the jamming effectiveness of individual techniques, because ECM techniques are involved with several complex parameters and they are usually entangled together. Therefore, the methodological approach for optimizing ECM techniques is based on purely conceptual analysis of the techniques. GRA

**N90-23630#** Mission Research Corp., Pacific Grove, CA.
**RADAR DETECTION DURING SCINTILLATION Technical Report, 1 Jan. - 31 Dec. 1988**
Dennis L. Knepp and J. T. Reinking Apr. 1990 66 p
(Contract DNA001-87-C-0169)
(AD-A220099; DNA-TR-89-82) Avail: NTIS HC A04/MF A01 CSCL 17/9

Electromagnetic signals that propagate through a disturbed region of the ionosphere can experience scattering which can cause fluctuations in the received amplitude, phase, and angle-of-arrival. This report considers the performance of a radar that must operate through a disturbed propagation environment such as might occur during strong equatorial scintillation, during a barium release experiment or after a high altitude nuclear detonation. The severity of the channel disturbance is taken to range from weak scattering where the signal quadrature components are uncorrelated Gaussian variates. The detection performance of noncoherent combining is compared to that of double threshold (M out of N) combining under various levels of scintillation disturbance. Results are given for detection sensitivity as a function of the scintillation index and the ratio of the radar hopping bandwidth to the channel bandwidth. It is shown that both types of combining can provide mitigation of fading, and that noncoherent combining generally enjoys an advantage in detection sensitivity of about 2 dB. This work serves as a quantitative guideline to the advantages and disadvantages of certain types of detection strategies during scintillation and is, therefore, useful in the radar design process. However, a detailed simulation of the radar detection algorithms is necessary to evaluate a radar design strategy to predict performance under scintillation conditions. GRA

**N90-23631#** BBN Systems and Technologies Corp., Cambridge, MA.
**HIGH-THROUGHPUT, SURVIVABLE PROTOCOLS FOR CDMA PACKET-RADIO NETWORKS (SRNTN-74)**
John Zavgren and Melisse Leib 1 Mar. 1990 39 p
(Contracts MDA903-83-C-0173; N00140-87-C-8910)
(AD-A220189; BBN-7173) Avail: NTIS HC A03/MF A01 CSCL 25/2

The result of our research is a suite of practical, implementable algorithms that a software developer can use to build a high-throughput, survivable Code-Division Multiple Access (CDMA) mobile packet radio network with existing spread-spectrum packet-radio hardware. The Code Division channel increases network throughout by allowing simultaneous transmissions to different destinations on the same frequency band. We have conducted extensive simulations to verify the performance of these protocols and we have determined they produce a high-throughput, survivable network. These protocols are an evolutionary step in packet-radio network architecture that starts with earlier pioneering work, most notably the work of Jubin et al. that is the basis of SURAP. We have adopted many SURAP algorithms to our CDMA network architecture, most notably its routing algorithms. GRA

**N90-23632#** Polytechnic Univ., Farmingdale, NY.
**SPECTRAL METHODS FOR ELECTROMAGNETIC PROPAGATION AND DIFFRACTION Final Report, 1 Jul. 1985 - 31 Dec. 1989**
L. B. Felsen 9 Mar. 1990 9 p
(Contract DAAG29-85-K-0180)
(AD-A220291; POLY-WRI-1572-90; ARO-2249.5-EL) Avail: NTIS HC A02/MF A01 CSCL 20/14

Analysis of source-excited time-harmonic and transient electromagnetic wave propagation in complicated environments, wave scattering by complicated targets, or wave penetration into complex structures generally requires decomposition of the incident field into elementary constituents, tracking each constituent through the environment or past the scatter, and recombining at the observer. The elementary constituents are spectral objects such as plane waves, cylindrical waves, conical waves, modal fields, ray field, etc. Under transient conditions, the recombination is conventionally performed first on the time-harmonic constituents, with frequency synthesis performed thereafter, but one may alternatively, by a less conventional approach, employ transient constituents (transient plane or cylindrical waves, etc.) and perform the remaining spatial synthesis thereafter. Viewed from this general perspective, there exists an enormous flexibility in the selection of the spectral objects, and of hybrid combinations, for analysis of a particular propagation or scattering problem. It is the objective of the proposed research to examine the various spectral options in their most fundamental terms, study the relation between them, and then assess which option best addresses a particular propagation or scattering phenomenon. GRA

**N90-23633#** Naval Postgraduate School, Monterey, CA.
**SIMULATION AND ANALYSIS OF A MFQPSK SIGNAL TRANSMITTED THROUGH AN ACOUSTIC MEDIUM M.S. Thesis**
Anita S. Daniel Dec. 1989 71 p
(AD-A220345) Avail: NTIS HC A04/MF A01 CSCL 20/14

A multi-frequency quadrature phase shift keyed (MFQPSK) signal has been developed at NPS to be used in computer-to-computer communications. This report discusses the simulation of a MFQPSK signal transmitted from a moving transmitter platform through a near vertical acoustic channel as seen by a moored receiver. The simulated received signal is tested against MFQPSK signal theory. The simulation was developed to be an experimental tool for testing various Doppler, synchronization, and coding algorithms/techniques for a MFQPSK communication signal. The degradation of output signal-to-noise ratio due to Doppler shifts caused by the moving transmitter is analyzed. An algorithm for estimating Doppler compression/expansion in the received signal is evaluated. GRA

**N90-23425** Centre National d'Etudes Spatiales, Toulouse (France).
**RADIO LINKS: INSTRUMENT TECHNOLOGIES**
Bruno Cugny *In its* Location and Navigation Satellite Systems

Mar. 1989 p 109-131 In FRENCH; ENGLISH summary (For primary document see N90-23420 17-12)
Copyright Avail: CEPADUES-Editions, 111 rue Nicolas-Vauquelin, 31100 Toulouse, France

**N90-23428** Centre d'Etudes et de Recherches, Toulouse (France).
**SIGNAL PROCESSING: KALMAN FILTERING**
Bernard Gimonet *In* CNES, Location and Navigation Satellite Systems Mar. 1989 p 287-300 In FRENCH; ENGLISH summary (For primary document see N90-23420 17-12)
Copyright Avail: CEPADUES-Editions, 111 rue Nicolas-Vauquelin, 31100 Toulouse, France

# 33 ELECTRONICS AND ELECTRICAL ENGINEERING

Includes test equipment and maintainability; components, e.g., tunnel diodes and transistors; microminiaturization; and integrated circuitry.

For related information see also *60 Computer Operations and Hardware* and *76 Solid-State Physics.*

**N90-23634#** Sandia National Labs., Albuquerque, NM.
**CMOS IC I(SUB DDQ) TESTING FOR THE 1990S**
Jerry M. Soden, Charles F. Hawkins (New Mexico Univ., Albuquerque.), Ronald R. Fitzenmeier, and John R. Guth 1990 4 p Presented at the VLSI Test Symposium, Atlantic City, NJ, 10-11 Apr. 1990
(Contract DE-AC04-76DP-00789)
(DE90-009508; SAND-90-0613C; CONF-9004174-1) Avail: NTIS HC A01/MF A01

Significant improvements in CMOSIC quality, reliability, and fabrication yield can be readily achieved in the 1990s by appropriate implementation of tests for quiescent power supply current (I(sub DDQ)). As part of an overall quality management program, I(sub DDQ) testing incorporated with design for testability and modified conventional logic response testing enables 100 percent stuck-at fault coverage, quality improvement goals of defective levels less than 100 PPM, and reliability greater than 0.999 for 30 years.
DOE

**N90-23635*** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**REFLECTION OSCILLATORS EMPLOYING SERIES RESONANT CRYSTALS' Patent**
Leonard L. Kleinberg, inventor (to NASA) 10 Oct. 1989 7 p Filed 30 Dec. 1988
(NASA-Case-GSC-13173-1; US-Patent-4,873,498; US-Patent-Appl-SN-292037; US-Patent-Class-331-116FE; US-Patent-Class-331-117FE; Int-Patent-Class-H03B-5/12) Avail: US Patent and Trademark Office CSCL 09A

A reflection oscillator is provided which employs an active device operated in its roll-off region and two resonant circuits. For an oscillator employing a bipolar transistor, the emitter is connected to a series resonant capacitor-crystal network and the base is connected to an L-C tank circuit with the transistor being operated in the roll-off region of its gain versus frequency curve. This will provide a very high frequency of operation with a relatively inexpensive, low frequency, active device. These oscillators are easily tuned, stable, and require little dc power.
Official Gazette of the U.S. Patent and Trademark Office

**N90-23636*** National Aeronautics and Space Administration. Pasadena Office, CA.
**LONG PERIOD PSEUDO RANDOM NUMBER SEQUENCE GENERATOR Patent**
Charles C. Wang, inventor (to NASA) 26 Dec. 1989 11 p Filed 29 Oct. 1987
(NASA-Case-NPO-17241-1-CU; US-Patent-4,890,252; US-Patent-Appl-SN-113954; US-Patent-Class-364-717; US-Patent-Class-364-746.1; Int-Patent-Class-G06F-1/02) Avail: US Patent and Trademark Office CSCL 09A

A circuit for generating a sequence of pseudo random numbers, (A sub K). There is an exponentiator in GF(2 sup m) for the normal basis representation of elements in a finite field GF(2 sup m) each represented by m binary digits and having two inputs and an output from which the sequence (A sub K). Of pseudo random numbers is taken. One of the two inputs is connected to receive the outputs (E sub K) of maximal length shift register of n stages. There is a switch having a pair of inputs and an output. The switch outputs is connected to the other of the two inputs of the exponentiator. One of the switch inputs is connected for initially receiving a primitive element (A sub O) in GF(2 sup m). Finally, there is a delay circuit having an input and an output. The delay circuit output is connected to the other of the switch inputs and the delay circuit input is connected to the output of the exponentiator. Whereby after the exponentiator initially receives the primitive element (A sub O) in GF(2 sup m) through the switch, the switch can be switched to cause the exponentiator to receive as its input a delayed output A(K-1) from the exponentiator thereby generating (A sub K) continuously at the output of the exponentiator. The exponentiator in GF(2 sup m) is novel and comprises a cyclic-shift circuit; a Massey-Omura multiplier; and, a control logic circuit all operably connected together to perform the function U(sub i) = 92(sup i) (for n(sub i) = 1 or 1 (for n(subi) = 0).
Official Gazette of the U.S. Patent and Trademark Office

**N90-23637#** Diamond Materials, Inc., State College, PA.
**DEVELOPMENT OF HIGH PERFORMANCE BETA-SiC FIELD-EFFECT TRANSISTORS Quarterly Technical Report No. 2, 21 Oct. 1989 - 20 Jan. 1990**
Richard Koba 14 Feb. 1990 8 p
(Contract N00014-89-C-0207)
(AD-A218392; DMI-TR-90003) Avail: NTIS HC A02/MF A01 CSCL 09/1

During the last three months of this Phase 2 program, Diamond Materials, Inc. (DMI), has: finished major equipment installations; identified a potentially superior source gas for beta-SiC CVD; and instituted an equipment inventory and maintenance system in compliance with Federal Acquisition Regulations (FARs). All proposed engineering upgrades to DMI's beta-SiC CVD reactor were installed and tested. DMI has installed its activated reactive evaporation (ARE) reactor which will be used for the deposition of cubic AlN and MgO dielectric films on beta-SiC. DMI has also installed a hot wall tube furnace which will be used for thermal oxidation of beta-SiC crystals to form SiO2. DMI has identified a proprietary source gas for the heteroepitaxial growth of beta-SiC on TiC substrates. This source gas promises to be greatly superior to the gas DMI is currently using, viz., methyltrichlorosilane (MTS). Use of MTS will probably hinder controlled in-situ doping of beta-SiC epi layers. DMI has identified a highly capable, specialty chemical company willing to synthesize and purify this source gas. DMI has written a proposal to a certain, large company requesting funding to develop this source gas. If this source gas is developed by private funding, then it will be acquired for use on this Government contract. DMI has also instituted an inventory and maintenance procedure for equipment purchased with Government funds, in compliance with FARs. GRA

**N90-23638#** Clemson Univ., SC.
**MICROELECTRONIC DEVICE RELIABILITY Final Report, Aug. 1986 - Aug. 1989**
James W. Harrison, Jr. 15 Jan. 1990 6 p
(Contract DAAL03-86-G-0066)
(AD-A218774; ARO-23786.1-EL-F) Avail: NTIS HC A02/MF A01 CSCL 09/1

Research on pulsed current electromigration in fine-line very large scale integration (VLSI) metallization was performed. A test structure containing 6 sample lines was designed in accordance with NBS recommendations (Ca. 1987) fabricated by an industrial firm and supplied to Clemson University for continued electromigration research. GRA

**N90-23639#** University of Southern California, Los Angeles.
**NEGATIVE ELECTRON AFFINITY FOR INFRARED DETECTION Final Report, 1 Jul. 1986 - 30 Sep. 1989**
Martin A. Gundersen 30 Sep. 1989 28 p
(Contract N00014-86-K-0510)
(AD-A218816) Avail: NTIS HC A03/MF A01 CSCL 09/5

The optical properties of gallium phosphide (GaP) were studied extensively, and the optical bistability of GaP device and a gallium phosphide infrared detector based on linear upconversion were examined. To detect upconverted infrared signal the photo-conducting scheme was tried. In this case the noise current by the pumping beam and imperfect surface state is too dominant to see the signal since the probe is directly contacted on the sample. The indication of infrared signal could be observed, but it is too weak to estimate the quantum efficiency. The sample surface defects and edge adsorption due to high impurity concentration are to be the reasons. Although the surface defects due to dangling bond and the band tailing effect are probably inherent in the system, it can be minimized by precise selection of the pump beam frequency. GRA

**N90-23640#** Department of the Air Force, Washington, DC.
**MICROWAVE TRANSMISSION LINE AND METHOD OF MODULATING THE PHASE OF A SIGNAL PASSED THROUGH SAID LINE Patent Application**
Richard A. Neifeld, inventor (to Air Force) 5 Feb. 1990 10 p
(AD-D014457; US-Patent-Appl-SN-474976) Avail: NTIS HC A02/MF A01 CSCL 09/1

A microwave transmission line is provided including a class of dielectric materials known as relaxor dielectrics having very dielectric constants of greater than 1000, low dielectric loss and large variations of the real part of the dielectric constant with varying temperature. The phase of a microwave signal passed through such a transmission line is modulated by subjecting the transmission line to light that is absorbed in the dielectric layer causing a variation in the dielectric constant and a change in the velocity of the continuous microwave signal passing through the transmission line. GRA

**N90-23641#** Rome Air Development Center, Griffiss AFB, NY.
**A PARAMETRIC DETECTION APPROACH USING MULTICHANNEL PROCESSES Report, Sep. 1988 - Aug. 1989**
James H. Michels Nov. 1989 70 p
(AD-A219328; RADC-TR-89-306) Avail: NTIS HC A04/MF A01 CSCL 09/1

The binary multichannel detection problem for an unknown random signal vector in additive nonwhite interference plus white Gaussian noise is considered. A generalized likelihood ratio is derived based on the vector error residuals from multichannel prediction error filters designed as minimum mean squared error estimates under each hypothesis. The observation processes are considered to have an arbitrary in time and across channels. A research investigation currently in progress is outlined. GRA

**N90-23642#** Naval Submarine Medical Research Lab., Groton, CT.
**FIELD CALIBRATION OF TWO TYPES OF MICROPHONES IN HYPERBARIC AIR Interim Report, Oct. 1988 - Oct. 1989**
Paul F. Smith, Susan Carpenter, and John Green 16 Jan. 1990 17 p
(AD-A219477; NSMRL-1153) Avail: NTIS HC A03/MF A01 CSCL 09/1

The response of two microphones, one a condenser microphone and the other a diaphragm-activated piezoelectric ceramic microphone, were measured in compressed air at pressures as great as 810 kilopascals (8 atmospheres). The response of each microphone was compared to that of a hydrophone operated in air as a microphone. The results show that the two types of microphone respond similarly to high ambient pressure. Both types are less sensitive to sound pressure in compressed air than in air at normal pressures, and the frequency responses of both microphones are altered. The results are useful in the analyses of ambient noise measurements done during experiments in compressed air. GRA

**N90-23643#** Defence Research Establishment, Ottawa (Ontario). Nuclear Effects Section.
**PULSE-WIDTH DEPENDENT RADIATION EFFECTS ON ELECTRONIC COMPONENTS**
T. Cousins Nov. 1989 28 p
(AD-A219517; DREO-TN-89-33) Avail: NTIS HC A03/MF A01 CSCL 09/1

The simulation of the prompt gamma-ray pulse effects on electronics with an electron linear accelerator (LINAC) has been performed by DREO and other groups. However, the use of a LINAC normally entails wider pulses than those expected on the battlefield. This report examines the effects of the variation of pulse width on electronic response using both theoretical and experimental examples. The conclusions are that pulse-width fidelity is important for a number of possible scenarios, and that for complete understanding of electronic performance, a variable pulse-width simulator is essential. GRA

**N90-23644#** Army Lab. Command, Fort Monmouth, NJ. Electronics Technology and Devices Lab.
**TEMPERATURE AND COUPLING BEHAVIOR OF RESONATORS AND TRANSDUCERS OF LITHIUM TETRABORATE DRIVEN BY LATERAL AND THICKNESS FIELDS Technical Report, Jun. 1988 - Jun. 1989**
Arthur Buffalo, John Kosinski, Muhammad Mizan, and Theodore Lukaszek Jan. 1990 88 p
(AD-A219548; SLCET-TR-90-1) Avail: NTIS HC A05/MF A01 CSCL 09/1

Lithium tetraborate is a tetragonal material of considerable promise for signal processing, transducer, and frequency control applications. It exhibits piezoelectric coupling values that fall between those of lithium niobate and quartz, but possesses orientations for which the temperature coefficient of frequency or delay time is zero for both bulk and surface acoustic waves. Calculations have previously been made for rotated y-cut, bulk wave plates, including the regions where the quasi-extensional and quasi-shear thickness modes have zero temperature coefficients of frequency. The calculation are extended to doubly rotated bulk wave resonators, and the coupling factors are computed for the three simple thickness modes driven by (TE) and lateral (LE) quasistatic electric fields as a function of the orientation angles phi and theta, and the direction of the applied lateral field psi. Because of the temperature coefficients of the piezoelectric coupling factors, the temperature coefficient of a resonator will depend not only upon orientation, but also upon harmonic number and location of the resonator operating point on the immittance circle. It is found that two unique orientations exist in lithium tetraborate for which plate resonators have zero temperature coefficients of frequency of both first- and second-order with high values of piezo coupling factor. One cut has this favorable behavior in its thickness-stretch mode, while the other possesses it for its slow thickness-shear mode. GRA

**N90-23645#** Naval Postgraduate School, Monterey, CA. Dept. of Electrical Engineering.
**MILLIMETER WAVE FILTER DESIGN WITH SUSPENDED STRIPLINE M.S. Thesis**
Anastasios K. Kotronis Sep. 1989 64 p
(AD-A219582) Avail: NTIS HC A04/MF A01 CSCL 20/14

Planar and integrated microwave circuitry for application in radar and guidance systems is predominantly based on the microstrip transmission medium. Due to high microstrip losses with increasing frequency, lower-loss media are required for frequencies at K sub c band (30 GHz) and above. These higher frequencies are coming into increased use for higher target resolution and improved security. The important alternative microwave transmission media which preserve the advantages of planar printed circuit forms are the finline and shielded suspended substrate systems. Of those two media, the finline has had extensive application and theoretical investigation. The shielded

suspended substrate stripline (SSL) has the potential for very low transmission loss since, in its quasi-TEM propagation mode, the current densities are very low due to its additional air gap, relative to microstrip. The SSL is at present a developmental system, and verified design rules are not yet available for it. A number of empirical formulas for the computation of the SSL transmission line parameters have been published in the literature, but the validity and accuracy of these formulas is not known. At present, essentially no information is available for discontinuities such as capacitive gaps or angles in the medium. The series capacitive gap is of particular interest in that a useful microwave filter can be built using resonator sections coupled by series capacitive gaps. GRA

**N90-23646#** Naval Postgraduate School, Monterey, CA. Dept. of Electrical and Computer Engineering.
**SERRODYNING BY MEANS OF A DIGITAL PHASE SHIFTER M.S. Thesis**
Meng-Yoon Tan Sep. 1989 108 p
(AD-A219593) Avail: NTIS HC A06/MF A01 CSCL 17/4

Serrodyning operation is employed by the velocity deception Electronic Countermeasures jammer to counter those radars utilizing a target's Doppler shift information. The jammer will frequency translate an incoming signal by a desired amount and at a specific rate during retransmission. If the radar follows the ECM signal, it is left without a target in its velocity gate when the ECM signal is turned off. The operation can be accomplished by either a TWT (Traveling Wave Tube) or a DPS (Digital Phase Shifter). The properties are determined of the spectrum of a sinusoidal signal which is phase modulated with a staircase waveform. The investigations include the study of the qualities of the output spectrum and the characteristics of the operation, e.g., number of steps (phase resolution), phase accuracy, switching speed, translation loss and suppression ratio. Results are verified by simulations as well as by measurements. GRA

**N90-23647#** Illinois Univ. at Urbana-Champaign, Savoy. Coordinated Science Lab.
**STATISTICAL DESIGN OF MOS VLSI (VERY LARGE SCALE INTEGRATED) CIRCUITS WITH DESIGNED EXPERIMENTS Ph.D. Thesis**
Tat-Kwan Edgar Yu Mar. 1990 114 p Sponsored in part by Semiconductor Research Corp. and Bell Telephone Labs.
(Contract N00014-84-C-0149)
(AD-A219654; UILU-ENG-90-2208; DAC-18) Avail: NTIS HC A06/MF A01 CSCL 09/1

A new approach for the statistical design and analysis of Metal Oxide Semiconductor is introduced. The proposed approach approximates the circuit performances, such as gain and delay, by fitted models. The fitted models are then used as surrogates of the circuit simulator to predict and optimize the parametric yield with computation efficiency and to achieve off-line quality control. The use of statistical design and analysis of experiments for model construction have been investigated theoretically and experimentally, and different methods to assess the adequacy of a fitted performance model were studied. GRA

**N90-23648#** Martin Marietta Space Systems, Inc., Denver, CO.
**TEST DIAGNOSTICS OF RF EFFECTS IN INTEGRATED CIRCUITS Final Report, Sep. 1987 - May 1989**
David D. Wilson, Stan Epshtein, Mark G. Rossi, and Christine L. Proffitt Feb. 1990 228 p
(Contract F30602-87-C-0079; AF Proj. 2338)
(AD-A219737; MCR-89-505; RADC-TR-89-355) Avail: NTIS HC A11/MF A02 CSCL 09/1

The results are presented for an effort to measure the RF upset susceptibilities of CMOS and low power Schottky integrated circuits and to demonstrate a test probe methodology for measuring RF noise coupling, generation, and propagation into and upon these integrated circuits chips. RF interference used was continuous wave CW from 1MHz to 200MHz. This was combined with the digital signal using an op-amp combiner and directly coupled into the device ports. Upset threshold voltage levels were measured, complex input impedances were measured, and upset power levels were calculated and plotted. A scanning electron microscope (SEM), quantitative voltage contrast (QVC) system was used to measure internal waveforms along the intended signal path, on adjacent metals runs, and an internal power and ground connections. GRA

**N90-23649#** Naval Postgraduate School, Monterey, CA. Dept. of Electrical and Computer Engineering.
**CIRCUIT RECOGNITION OF VLSI LAYOUTS M.S. Thesis**
Joel V. Swisher Sep. 1989 113 p
(AD-A219806) Avail: NTIS HC A06/MF A01 CSCL 09/1

The design process of a very large scale integrated (VLSI) circuit is time consuming, with design verification and timing analysis being two of the most tedious stages. The development of a computer-aided design (CAD) tool that verifies circuit design and timing will reduce the design time. The primary contribution is to provide an initial tool that will assist VLSI designers with the verification of a circuit's design. This tool is the first of several modular programs which will give the designer the capability to quickly and accurately verify a VLSI circuit's design and timing. The primary goal is to develop an algorithm that will recognize different elements within the simulation file of a Complementary Metal Oxide Silicon (CMOS) circuit. Several simulation files were obtained using Magic which is a layout editing system developed at the University of California, Berkeley. These simulation files were analyzed and a C program was written that would accomplish circuit recognition. GRA

**N90-23650#** Rome Air Development Center, Griffiss AFB, NY.
**VALIDATION OF SHIELDING EFFECTIVENESS OF CABLES WITH PIGTAILS Report, Mar. - Aug. 1989**
Timothy W. Blocher Mar. 1990 54 p
(AF Proj. 2338)
(AD-A220647; RADC-TR-90-51) Avail: NTIS HC A04/MF A01 CSCL 09/7

This report focuses on the validation of experimental data used to develop the field-to-wire coupling algorithm in the Intrasystem Electromagnetic Compatibility Analysis Program (IEMCAP). IEMCAP is a computer code used to assess the electromagnetic compatibility (EMC) of Air Force systems. The experimental data of interest was obtained by measuring, in a mode tuned reverberation chamber (MTRC), the shielding effectiveness (SE) of coaxial cables terminated in pigtails. The results of these measurements indicate that a coaxial cable terminated in pigtail has no shielding from electromagnetic interference (EMI). When repeating these measurements, it was found that coaxial cables terminated in pigtails can have a degree of SE. Due to the opposing results, the various characteristics of pigtails, such as length and construction, are investigated to determine which pigtail attributes critically reduce the SE of coaxial cables. From this investigation, the parameters that critically reduce the SE of coaxial cables are identified. Recommendations are then made regarding the field-to-wire coupling algorithm in IEMCAP and regarding follow-up investigations. GRA

**N90-23651#** Cornell Univ., Ithaca, NY. School of Electrical Engineering.
**ULTRA HIGH-SPEED COMPOUND SEMICONDUCTORS AND REAL TIME SIGNAL PROCESSING Annual Report, 1 May 1989 - 30 Apr. 1990**
J. Peter Krusius 1 Mar. 1990 51 p
(Contract F49620-87-C-0044)
(AD-A220721) Avail: NTIS HC A04/MF A01 CSCL 09/1

This report is the annual report on research conducted under the auspices of the Joint Services Electronics Program at Cornell University. The research is grouped under two themes: (1) ultra high speed compound semiconductors, and (2) real time signal processing. Results on organometallic vapor phase epitaxy (OMVPE) materials growth, femtosecond laser probing of hot carriers, and ensemble Monte Carlo simulations are reported on under the first theme. Accomplishments on VLSI algorithms, fault

tolerant architectures, and architectures with multiple functional units for signal processing are given under the second theme. GRA

**N90-23652#** Washington Univ., Seattle. Dept. of Computer Science.
**VLSI ARCHITECTURES AND CAD Semiannual Technical Report No. 3, 4 Apr. - 1 Nov. 1989**
Lawrence Snyder 1 Nov. 1989 12 p
(Contract N00014-88-K-0453)
(AD-A220736; NWLIS-89-30-03) Avail: NTIS HC A03/MF A01 CSCL 09/1

The contents included are: Overview of Activities; A Unified Behavioral/Structural Representation for Simulation and Synthesis; A Circuit Specification Language that Combines Graphics and Procedures; Timing Optimization of Multi-phase Logic; Comparing Synchronization Strategies for Parallel Logic-Level Simulation; A Hybrid Compiled/Interpreted Approach to Switch-Level Simulation; Normalized Time and its Use in Architectural Design; Work on a Low-Cost Programmable Chip Tester; Hardware Assist for Performance Evaluation of Multi-Processors; Hardware-Based Data Compression; Reconfigurable Logic Arrays; Testing of Asynchronous Circuits. GRA

**N90-23653#** Washington Univ., Seattle. Dept. of Computer Science and Engineering.
**UW VLSI CHIP TESTER**
Neil McKenzie 1 Dec. 1989 24 p
(Contract N00014-88-K-0453; ER-0030)
(AD-A220789; NWLIS-89-12-01) Avail: NTIS HC A03/MF A01 CSCL 09/1

We present a design for a low-cost, functional VLSI chip tester. It is based on the Apple MacIntosh II personal computer. It tests chips that have up to 128 pins. All pin drivers of the tester are bidirectional; each pin is programmed independently as an input or an output. The tester can test both static and dynamic chips. Rudimentary speed testing is provided. Chips are tested by executing C programs written by the user. A software library is provided for program development. Tests run under both the Mac Operating System and A/UX. The design is implemented using Xilinx Logic Cell Arrays. Price/performance tradeoffs are discussed. GRA

**N90-23654#** Ohio State Univ., Columbus.
**JOINT SERVICES ELECTRONICS PROGRAM Annual Report, No. 12**
Leon Peters, Jr. Nov. 1989 82 p
(Contract N00014-89-K-1007)
(AD-A220815; Rept-721563-1) Avail: NTIS HC A05/MF A01 CSCL 09/1

Discussed are diffraction by non-conducting and penetrable surfaces; scattering by open-ended waveguide cavities; diffraction by a corner in a perfectly conducting planar surface, and equivalent currents for reentry bodies. Papers include: JSEP diffraction studies; Integral Equation Studies; chiral media; artificial dielectrics; variational properties of the moment method; nonlinear media; hybrid analysis of microstrip configurations; hybrid analysis of EM scattering by antenna cavity configurations; hybrid analysis of EM scattering from complex structures; nulling bandwidth of adaptive arrays; packet radio networks with adaptive arrays; array pattern synthesis using adaptive array concepts; and element reuse in adaptive arrays. GRA

**N90-23655#** Texas Univ., Austin. Electronics Research Center.
**JOINT SERVICES ELECTRONICS PROGRAM: ELECTRONICS RESEARCH AT THE UNIVERSITY OF TEXAS AT AUSTIN Annual Report No. 40, 1 Jan. - 31 Dec. 1989**
Edward J. Powers 31 Dec. 1989 99 p
(Contract F49620-89-C-0044)
(AD-A220834) Avail: NTIS HC A05/MF A01 CSCL 09/1

This report summarizes scientific progress on Basic Research in Electronics which has been conducted under the auspices of the DoD Joint Services Electronics Program during the period 1 January to 31 December 1989. Progress on five solid-state, two information electronics, and two electromagnetic projects is described. Information electronics, electromagnetics, solid-state electronics, molecular beam epitaxy, semiconductor surfaces, charge transport, femtosecond processes, heterostructure device, millimeter wave active guided wave structures, and nonlinear wave phenomena are examined. GRA

**N90-23656#** Washington Univ., Seattle.
**TIMING OPTIMIZATION OF MULTI-PHASE SEQUENTIAL LOGIC**
Karen Bartlett, Gaetano Borriello, and Sitaram Raju Dec. 1989 15 p
(Contract N00014-88-K-0453)
(AD-A220836; NW-LIS-89-12-05) Avail: NTIS HC A03/MF A01 CSCL 09/1

High-performance MOS circuits are frequently designed using pre-charged and dynamic logic. This requires the use of multiple phases of the system clock to ensure that the circuitry is pre-charged and refreshed at the proper times during each clock cycle. Finite-state machines used to control this type of logic must therefore be constructed as multi-phase sequential logic with inputs and outputs stable during the appropriate phases. The timing optimization of multi-phase logic entails the reduction of the overall cycle time of the machine as well as input to output delays by distributing computation throughout the entire clock cycle. Currently, no tools are available to automatically perform this optimization task for multi-phase logic. We have developed such a tool as a set of extensions to the combinational logic optimization tool, misII. Our algorithms yield improvements that are 20 percent better than what is achievable using only combinational logic optimization tools that do not move logic across latches. Furthermore, we achieve 65 percent of the improvements possible in the circuits show average input to output delay improvements of almost 20 percent with area penalties of less than 12 percent. For a four-phase controller used in the SPUR processor it yields an improvement in cycle time of 21 percent with an area penalty of 21 percent. GRA

**N90-23657#** Technische Univ., Eindhoven (Netherlands). Vakgroep Elektromechanica en Vermogenselektronica.
**COORDINATE TRANSFORMATION FOR AN ASYNCHRONOUS, MACHINE, AND TIME DISCRETIZATION OF A STATE OBSERVER Thesis [COOERDINATENTRANSFORMATIE VOOR, EN TIJDSDISCRETISATIE VAN EEN TOESTANDSWAARNEMER VOOR EEN ASYNCHRONE MACHINE]**
J. A. J. M. Geerligs May 1988 237 p In DUTCH; ENGLISH summary
(EMV-88-30; ETN-90-96729) Avail: NTIS HC A11/MF A02

A state observer was designed, realized and tested for the rotor flux determination of an asynchronous machine, supplied via a voltage inverter. A coordinate transformation of the input signals from the stator system to an arbitrary intermediate system was realized. The transition from a time continuous model of the state observer to a time discrete model was investigated. The application of the state transition model seems to offer good prospects. A method of computing the state transition matrix based on the Sylvester expansion theorem was developed. The stability of the digital state observer in the case of constant angular velocities of the rotor and the intermediate system is discussed. ESA

**N90-23658#** Technische Univ., Eindhoven (Netherlands). Vakgroep Elektromechanica en Vermogenselektronica.
**DESIGN, SIMULATION, AND TESTING OF A FIELD-ORIENTED ac SERVO-DRIVE USING A TM5 32010 SIGNAL PROCESSOR Thesis [ONTWERP, SIMULATIE EN BEPROEVING VAN EEN FLUXGEORIENTEERDE AC-SERVO-AANDRIJVING MBV EEN TMS32010-SIGNAALPROCESSOR]**
P. L. Wilms Aug. 1988 174 p In DUTCH; ENGLISH summary
(EMV-88-42; ETN-90-96730) Avail: NTIS HC A08/MF A01

The design, realization and testing of a servo drive with an asynchronous machine (an ac servo drive) were studied. The

asynchronous machine is described by a mathematical model using space vectors. Based on this model, a digital field-oriented speed control was designed using an ideal current source. A characteristic property of this control scheme is that only machine parameter (the rotor time constant) has to be known. The motor model and speed control were simulated with varying parameters such as calculation interval, sampling time and rotor time constant. The speed control was realized as a digital control system with a signal processor operating at a 2 KHz sampling frequency. Test results show that the designed speed control has stable and robust characteristics, and can thus be used in a cascade control of a servo drive. ESA

**N90-23659#** Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Numerical Mathematics.
**NONLINEAR MULTIGRID APPLIED TO A 1D STATIONARY SEMICONDUCTOR MODEL**
P. M. deZeeuw Feb. 1989 33 p
(CWI-NM-R8905; ETN-90-96733) Copyright Avail: NTIS HC A03/MF A01

The nonlinear multigrid method is applied to a transistor problem in one dimension. A weak spot in the linearization of the Scharfetter-Gummel discretization scheme is reported. It is shown that both the residual transfer and the solution transfer from a fine to a coarse grid need a special requirement due to the rapidly varying coefficients. Some modifications of the multigrid algorithm are proposed. ESA

**N90-23660#** Utah Univ., Salt Lake City. Center of Engineering Design.
**ELECTROMAGNETIC MACHINES WHICH UTILIZE MICROGEOMETRY FIELD STRUCTURES Final Report, 20 Aug. 1984 - 30 Jun. 1987**
S. C. Jacobsen and John E. Wood Apr. 1990 158 p
(Contract F33615-84-C-5092; AF Proj. 4587)
(AD-A219828; WRDC-TR-90-4015) Avail: NTIS HC A08/MF A01 CSCL 09/1

The Microfield Project at the Center for Engineering Design was originally motivated by a quest to understand how to improve the performance of actuators in demanding applications such as robots and artificial limbs. It was determined that by making the internal interactive elements of the system (actuator) numerous, closely packed, and very small (on the order of one to ten microns), sizeable force outputs and power densities could be produced, with improvements in impedance characteristics over conventional actuators. A by-product of these studies was the generation of a number of very interesting spin-off applications for microelectromechanical systems in general, including mechanical sensors, optical devices, actuators, and chemical sensors. Thus, for the Microfield Project, multiple exploratory investigations, both experimental and analytical, were undertaken aimed at: (1) understanding important issues necessary for the systematic design, analysis, fabrication, and testing of micro electromechanical sensors and actuators, and (2) establishing the feasibility of various concepts. GRA

**N90-23661#** Polytechnic Univ., Farmingdale, NY. Research Inst.
**BASIC RESEARCH IN ELECTRONICS (JSEP) Annual Report, 1 Jan. - 31 Dec. 1989**
Erich E. Kunhardt 31 Dec. 1989 53 p
(Contract F49620-88-C-0075)
(AD-A219931; POLY-WRI-1571-90) Avail: NTIS HC A04/MF A01 CSCL 09/1

The scientific progress and accomplishments on research projects in the Joint Services Electronics Program (JSEP) for the contract period from 1 January 1989 through 31 December 1989 are presented. The Joint Services Electronics Program at Polytechnic University is the core of interdisciplinary research in electronics encompassing programs in the Department of Electrical Engineering, Physics, and Chemistry under the aegis of the Weber Research Institute. The research encompassed by this program is grouped under two broad categories: Interactions of Wide-Band Electromagnetic Radiation with Complex Macro- and Micro-Structures (EM1) and Field-Particle Interactions in Matter; Single Particle, collective and Cooperative Phenomena (FP). GRA

**N90-23662*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**NEW DIRECTIONS IN InP SOLAR CELL RESEARCH**
I. Weinberg, C. K. Swartz, and D. J. Brinker 1990 7 p Proposed for presentation at the 25th Intersociety Energy Conversion Engineering Conference, Reno, NV, 12-17 Aug. 1990; cosponsored by AIChE, SAE, ACS, AIAA, ASME, and IEEE
(NASA-TM-103160; E-5528; NAS 1.15:103160) Avail: NTIS HC A02/MF A01 CSCL 10A

Recent research efforts representing new directions in InP solar cell research are reviewed. These include heteroepitaxial growth on silicon and gallium arsenide substrates, V-grooved cells, large area high efficiency cells, and surface passivation. Improvements in heteroepitaxial cell efficiency are described together with processing of 19.1 percent, 4 sq cm cells. Recommendations are made for improvements in processing leading to increased efficiencies. Author

**N90-23663*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**HIGH FREQUENCY, HIGH TEMPERATURE SPECIFIC CORE LOSS AND DYNAMIC B-H HYSTERESIS LOOP CHARACTERISTICS OF SOFT MAGNETIC ALLOYS**
W. R. Wieserman, G. E. Schwarze, and J. M. Niedra (Sverdrup Technology, Inc., Brookpark, OH.) 1990 8 p Proposed for presentation at the 25th Intersociety Energy Conversion Engineering Conference, Reno, NV, 12-17 Aug. 1990; cosponsored by AIChE, SAE, ACS, AIAA, ASME, and IEEE
(NASA-TM-103164; E-5536; NAS 1.15:103164) Avail: NTIS HC A02/MF A01 CSCL 09C

Limited experimental data exists for the specific core loss and dynamic B-H loops for soft magnetic materials for the combined conditions of high frequency and high temperature. This experimental study investigates the specific core loss and dynamic B-H loop characteristics of Supermalloy and Metglas 2605SC over the frequency range of 1 to 50 kHz and temperature range of 23 to 300 C under sinusoidal voltage excitation. The experimental setup used to conduct the investigation is described. The effects of the maximum magnetic flux density, frequency, and temperature on the specific core loss and on the size and shape of the B-H loops are examined. Author

**N90-23664*#** Johns Hopkins Univ., Baltimore, MD. Center for Nondestructive Evaluation.
**ACOUSTO-ULTRASONIC NONDESTRUCTIVE EVALUATION OF MATERIALS USING LASER BEAM GENERATION AND DETECTION M.S. Thesis**
Robert D. Huber and Robert E. Green, Jr. 1990 97 p
(Grant NAG3-728)
(NASA-CR-186694; NAS 1.26:186694) Avail: NTIS HC A05/MF A01 CSCL 09C

The acousto-ultrasonic method has proven to be a most interesting technique for nondestructive evaluation of the mechanical properties of a variety of materials. Use of the technique or a modification thereof, has led to correlation of the associated stress wave factor with mechanical properties of both metals and composite materials. The method is applied to the nondestructive evaluation of selected fiber reinforced structural composites. For the first time, conventional piezoelectric transducers were replaced with laser beam ultrasonic generators and detectors. This modification permitted true non-contact acousto-ultrasonic measurements to be made, which yielded new information about the basic mechanisms involved as well as proved the feasibility of making such non-contact measurements on terrestrial and space structures and heat engine components. A state-of-the-art laser based acousto-ultrasonic system, incorporating a compact pulsed laser and a fiber-optic heterodyne interferometer, was delivered to the NASA Lewis Research Center. Author

**N90-23665#** Technische Univ., Eindhoven (Netherlands). Vakgroep Elektromechanica en Vermogenselektronica.
**A HIGH FREQUENCY (20 kHz) POWER ELECTRONICS REACTIVE-CURRENT COMPENSATOR WITH INSULATED GATE BIPOLAR TRANSISTORS AS SEMICONDUCTOR SWITCHES Thesis [EEN HOOG-FREQUENTE (20 KHZ) VERMOGENSELECTRONISCHE BLINDSTROOMCOMPENSATOR MET IGBT'S ALS HALFGELEIDERSCHAKELAARS]**
G. J. J. deLeijer Dec. 1988 51 p In DUTCH; ENGLISH summary
(EMV-88-54; ETN-90-96731) Avail: NTIS HC A04/MF A01

The principle, the power converter, and the pulse pattern generator of a high frequency power reactive-current compensation for the climination of the instantaneous reactive currents in a three phase grid are discussed. The time-averaged analysis of reactive currents was accomplished for a single phase supply, whereas the instantaneous analysis was accomplished for a three-phase grid. The instantaneous analysis shows that it is possible to build a reactive-current compensator without using an energy buffer (i.e., a compact converter). The topology of the compensator corresponds with a current-source inverter shortened at the dc side. The inverter of the compensator uses insulated gate bipolar transistors. The pulse pattern generator is a realtime device operating according to the formulas of the instantaneous analysis. ESA

**N90-23666#** Technische Univ., Eindhoven (Netherlands). Vakgroep Elektromechanica en Vermogenselektronica.
**AN ULTRASONIC-SWITCHING THREE PHASE CURRENT SOURCE INVERTER WITH INSULATED GATE BIPOLAR TRANSISTORS Thesis [EEN ULTRASOON SCHAKELENDE DRIEFASENSTROOMINVERTOR, UITGEVOERD MET INSULATED GATE BIPOLAR TRANSISTOR]**
A. C. Blom Aug. 1989 109 p In DUTCH; ENGLISH summary
(EMV-89-11; ETN-90-96732) Avail: NTIS HC A06/MF A01

Insulated Gate Bipolar Transistor (IGBT) were applied in ultrasonic switching current source inverters for power purposes. The current source inverter is supplied by a current mode controlled chopper. Both parts, the inverter as well as the chopper consist of IGBT which enable the use of a 20 kHz switching frequency. The current source inverter is controlled by using a periodic switching pattern, generated by a partly free-programmable control systems consisting of a computer and a controllable external memory containing several tables of switching patterns. An output power of 4 kW is attained, demonstrating the applicability of IGBT in ultrasonic switching current source inverters for power purposes. ESA

**N90-23667#** Ecole Centrale de Lyon (France). Lab. d'Electrotechnique.
**STUDY AND SIMULATION OF THE BEHAVIOR OF A HIGH FREQUENCY TRANSFORMER Ph.D. Thesis [ETUDE ET SIMULATION DU COMPORTEMENT DU TRANSFORMATEUR EN HAUTES FREQUENCES]**
Ghazi Bousaleh 1989 183 p In FRENCH Sponsored by Electricite de France and Fondation Hariri
(ECL-89-008; ETN-90-96942) Avail: NTIS HC A09/MF A01

A numerical model of a transformer is developed to help in carrying out insulation dimensioning studies. The frequency behavior of the transformer can be studied using this model. Different types of transformer simulation models are discussed. Particular attention is given to scale models and mathematical models. The model chosen for this study is described in detail. The simulation software used is outlined. The test procedure is described. The model is shown to be a valid means of determining insulation dimensions within transformers. A simple global model of a transformer is proposed based on modal experimental analysis. ESA

# 34 FLUID MECHANICS AND HEAT TRANSFER

Includes boundary layers; hydrodynamics; fluidics; mass transfer; and ablation cooling.

For related information see also *02 Aerodynamics* and *77 Thermodynamics and Statistical Physics.*

**N90-23668** Rutgers Univ., New Brunswick, NJ.
**THREE-DIMENSIONAL CONVECTION IN CYLINDRICAL GEOMETRY Ph.D. Thesis**
Alessandro Bottaro 1989 163 p
Avail: Univ. Microfilms Order No. DA8923587

A few convective flows inside cylindrical open or closed bodies are studied numerically. The simulations are carried out with a finite volume code, that solves for the governing Navier-Stokes and energy equations in conservative form. Convective and diffusive fluxes are discretized by the use of central differencing, and the solutions are obtained by marching in time. A new way of treating the axis of the cylinder is presented. The configurations considered scan a vast range of physical effects. The two most important problems analyzed are: three dimensional natural convection in the Czochralski melt, and three dimensional opposing mixed convection in an inclined pipe. The first problem is relevant to crystal growers. The knowledge of the free convective motion in the melt is important, since unsteady convective flows are responsible for striations in the crystal. In the idealized geometry considered, it is observed that the motion of a very low Prandtl number fluid is axisymmetric and has swirl, the azimuthal motion being concentrated close to the axis. Azimuthal components of velocity are caused by small perturbations that grow through a process of energy exchange between the radial and azimuthal directions. It is found that the onset of unsteadiness (oscillatory flow) is close to what is predicted by two dimensional axisymmetric simulations. In the second configuration, an inclined pipe in which natural and forced convection oppose each other, is considered. This problem has applications in all situations involving the transport of heated or cooled fluids, such as heat exchangers, thermosyphons, and heat pipes. The focus is on the dependence of the flow on the angle of inclination and Grashof number. In certain ranges of the flow parameters, the fluid separates at the wall and penetrates a cold region. Under these circumstances, the flow does not have any symmetry and is fully three dimensional. Dissert. Abstr.

**N90-23669** Stanford Univ., CA.
**EXPERIMENTAL STUDY OF A THREE-DIMENSIONAL SHEAR-DRIVEN TURBULENT BOUNDARY LAYER WITH STREAMWISE ADVERSE PRESSURE GRADIENT Ph.D. Thesis**
David Michael Driver 1989 293 p
Avail: Univ. Microfilms Order No. DA8925857

Experiments were performed on an axially-symmetric, three-dimensional, shear driven turbulent boundary layer under varying degrees of adverse pressure gradient. Detailed measurements of the mean and fluctuating flow field were used to assess the size of terms in the transport equations for momentum and turbulent stresses. The measurements were also used to test various turbulence modeling assumptions. As in earlier experiments by others, this study demonstrates the slow response of the stress field to rapid changes in the mean flow strain-rate (lag phenomenon), and shows that the Reynolds stress decreases relative to equivalent two-dimensional flows. The decrease in shear stress in cases cannot be attributed exclusively to three-dimensionality of the mean flow—although some of the stress decrease is the result of three-dimensionality. Under sustained streamwise adverse pressure gradient the transverse mean flow and the transverse shear stresses decayed more rapidly than under zero pressure gradient conditions (also measured). As expected, adverse pressure gradient retarded the streamwise mean flow and contributed to reducing the streamwise component of Reynolds shear stress in the inner region. However, the usual rapid growth of the streamwise stress in the outer region was reduced in regions

with strong transverse strain. For this reason, it is hypothesized that a three-dimensional boundary layer is more prone to separate than is a two dimensional boundary layer, although it could not be proven here. Turbulence modeling of this flow revealed the strengths and weaknesses of several models. Dissert. Abstr.

**N90-23670*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**AERODYNAMIC PRESSURE AND HEATING-RATE DISTRIBUTIONS IN TILE GAPS AROUND CHINE REGIONS WITH PRESSURE GRADIENTS AT A MACH NUMBER OF 6.6**
L. Roane Hunt and Kristopher K. Notestine (PRC Kentron, Inc., Hampton, VA.) Washington Jun. 1990 70 p
(NASA-TP-2988; L-16649; NAS 1.60:2988) Avail: NTIS HC A04/MF A01 CSCL 20D

Surface and gap pressures and heating-rate distributions were obtained for simulated Thermal Protection System (TPS) tile arrays on the curved surface test apparatus of the Langley 8-Foot High Temperature Tunnel at Mach 6.6. The results indicated that the chine gap pressures varied inversely with gap width because larger gap widths allowed greater venting from the gap to the lower model side pressures. Lower gap pressures caused greater flow ingress from the surface and increased gap heating. Generally, gap heating was greater in the longitudinal gaps than in the circumferential gaps. Gap heating decreased with increasing gap depth. Circumferential gap heating at the mid-depth was generally less than about 10 percent of the external surface value. Gap heating was most severe at local T-gap junctions and tile-to-tile forward-facing steps that caused the greatest heating from flow impingement. The use of flow stoppers at discrete locations reduced heating from flow impingement. The use of flow stoppers at discrete locations reduced heating in most gaps but increased heating in others. Limited use of flow stoppers or gap filler in longitudinal gaps could reduce gap heating in open circumferential gaps in regions of high surface pressure gradients. Author

**N90-23671#** Catholic Univ. of America, Washington, DC.
**ADVANCED INSTRUMENTATION FOR LOCAL MEASUREMENT OF GAS-SOLID SUSPENSION FLOWS Quarterly Technical Report No. 11**
S. C. Ling and H. P. Pao 1990 5 p
(Contract DE-FG22-86PC-90956)
(DE90-008498; DOE/PC-90956/T9) Avail: NTIS HC A01/MF A01

An advanced optical technique was developed for the measurement of suspended-solid flows. This optical technique permits detailed experimental observation and analyses on the mechanics of sedimentary flows. The existence of microhairpin vortices as a major mechanism for the lifting of solid particles from the bottom flow boundary was identified and reported. A computational effort to study the detailed behavior of the microhairpin vortices was initiated. The purpose of this computational study is to follow in detail the evolution of the three-dimensional hairpin vortices in the boundary layer, and to investigate the roles of these vortices on the lifting mechanisms of solid particles by the strong suction provided by these intense micro-vortices. Author

**N90-23672** Arizona Univ., Tucson.
**NUMERICAL STUDY OF THE ONSET OF INSTABILITY IN THE FLOW PAST A SPHERE Ph.D. Thesis**
Inchul Kim 1989 128 p
Avail: Univ. Microfilms Order No. DA9003490

Experiment shows that the steady axisymmetric flow past a sphere becomes unstable in the range 120 less than Re less than 300. The resulting time-dependent nonaxisymmetric flow gives rise to nonaxisymmetric vortex shedding at higher Reynolds numbers. A computational investigation of the linear stability of the axisymmetric base flow is reported. When the sphere is towed, fixed, or otherwise constrained, stability is determined solely by the Reynolds number. On the other hand, when the sphere falls due to gravity, an additional parameter, the ratio of fluid density to sphere density (beta = rho(f)/rho(s)) is involved. A spectral technique is used to compute the steady axisymmetric flow, which is in closer agreement with experiment than previous calculations. A linear stability analysis of the base flow is performed with respect to axisymmetric and nonaxisymmetric disturbances. A spectral technique similar to that employed in the base flow calculation is used to solve the linear disturbance equations in streamfunction form for axisymmetric form for disturbances, and in a modified primitive variable form for nonaxisymmetric disturbances. For the density ratio beta = 0, which corresponds to a fixed sphere, the analysis shows that the axisymmetric base flow undergoes a Hopf bifurcation at Re = 175.1, with the critical disturbance having azimuthal wavenumber m = 1. The results are favorably compared to previous experimental work. Dissert. Abstr.

**N90-23673** Connecticut Univ., Storrs.
**COMPUTATIONS OF A HORSESHOE VORTEX AROUND AN ENDWALL-MOUNTED CYLINDER Ph.D. Thesis**
Craig Allen Wagner 1989 258 p
Avail: Univ. Microfilms Order No. DA9003836

Numerical predictions of the horseshoe vortex formed around an endwall mounted cylinder, using the Reynolds averaged, steady, incompressible Navier-Stokes equations, are compared to experimental measurements. The flow is fully turbulent with a Reynolds number of 550,000 based on inlet velocity and cylinder diameter. An existing computer code, INS3D, was originally applied to compute this flow field. Difficulties associated with the convergence and accuracy of this code for predicting this class of flows required the development and implementation of algorithmic improvements. Discussions of the extensive modifications made and improved accuracy and convergence characteristics, which resulted in the NAV3D computer code, are given. Two dimensional test cases and laminar flow around an endwall mounted cylinder are used to show the enhanced capability. The implementation and validation of an algebraic eddy viscosity model and k-epsilon model for turbulent flow are discussed. Difficulties associated with applying each model to the endwall cylinder flow allowed only the algebraic eddy viscosity model to be used. These difficulties are examined. For the case using the simple eddy viscosity model, two different size meshes were used. One mesh contains 265,320 points and the other has 442,200 points. Each solution is compared to experimental data with discussions on the degree of correlation. Suggestions are given for improving the accuracy of the solution in areas of poor correlation. Dissert. Abstr.

**N90-23674*#** Arizona Univ., Tucson. Dept. of Aerospace and Mechanical Engineering.
**NONLINEAR INTERACTIONS IN MIXING LAYERS AND COMPRESSIBLE HEATED ROUND JETS Ph.D. Thesis Final Report**
Yousef Mohd Jarrah 1989 171 p
(Grant NAG3-485)
(NASA-CR-186303; NAS 1.26:186303) Avail: NTIS HC A08/MF A01 CSCL 20D

The nonlinear interactions between a fundamental instability mode and both its harmonics and the changing mean flow are studied using the weakly nonlinear stability theory of Stuart and Watson, and numerical solutions of coupled nonlinear partial differential equations. The first part focuses on incompressible cold (or isothermal; constant temperature throughout) mixing layers, and for these, the first and second Landau constants are calculated as functions of wavenumber and Reynolds number. It is found that the dominant contribution to the Landau constants arises from the mean flow changes and not from the higher harmonics. In order to establish the range of validity of the weakly nonlinear theory, the weakly nonlinear and numerical solutions are compared and the limitation of each is discussed. At small amplitudes and at low-to-moderate Reynolds numbers, the two results compare well in describing the saturation of the fundamental, the distortion of the mean flow, and the initial stages of vorticity roll-up. At larger amplitudes, the interaction between the fundamental, second harmonic, and the mean flow is strongly nonlinear and the numerical solution predicts flow oscillations, whereas the weakly nonlinear

theory yields saturation. In the second part, the weakly nonlinear theory is extended to heated (or nonisothermal; mean temperature distribution) subsonic round jets where quadratic and cubic nonlinear interactions are present, and the Landau constants also depend on jet temperature ratio, Mach number and azimuthal mode number. Under exponential growth and nonlinear saturation, it is found that heating and compressibility suppress the growth of instability waves, that the first azimuthal mode is the dominant instability mode, and that the weakly nonlinear solution describes the early stages of the roll-up of an axisymmetric shear layer. The receptivity of a typical jet flow to pulse type input disturbance is also studied by solving the initial value problem and then examining the behavior of the long-time solution. Author

**N90-23675*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**EQUILIBRIUM RADIATIVE HEATING TABLES FOR EARTH ENTRY**
Kenneth Sutton and Lin C. Hartung May 1990 28 p
(NASA-TM-102652; NAS 1.15:102652) Avail: NTIS HC A03/MF A01 CSCL 20D

The recent resurgence of interest in blunt-body atmospheric entry for applications such as aeroassisted orbital transfer and planetary return has engendered a corresponding revival of interest in radiative heating. Radiative heating may be of importance in these blunt-body flows because of the highly energetic shock layer around the blunt nose. Sutton developed an inviscid, stagnation point, radiation coupled flow field code for investigating blunt-body atmospheric entry. The method has been compared with ground-based and flight data, and reasonable agreement has been found. To provide information for entry body studies in support of lunar and Mars return scenarios of interest in the 1970's, the code was exercised over a matrix of Earth entry conditions. Recently, this matrix was extended slightly to reflect entry vehicle designs of current interest. Complete results are presented. Author

**N90-23676*#** Institute for Computer Applications in Science and Engineering, Hampton, VA.
**ALGEBRAIC TURBULENCE MODELING FOR UNSTRUCTURED AND ADAPTIVE MESHES Final Report**
Dimitri J. Mavriplis May 1990 31 p Submitted for publication
(Contract NAS1-18605)
(NASA-CR-182035; NAS 1.26:182035; ICASE-90-30) Avail: NTIS HC A03/MF A01 CSCL 20D

An algebraic turbulence model based on the Baldwin-Lomax model, was implemented for use on unstructured grids. The implementation is based on the use of local background structured turbulence meshes. At each time-step, flow variables are interpolated from the unstructured mesh onto the background structured meshes, and the resulting eddy viscosity values are interpolated back to the unstructured mesh. Modifications to the algebraic model were required to enable the treatment of more complicated flows, such as confluent boundary layers and wakes. The model is used in conjunction with an efficient unstructured multigrid finite-element Navier-Stokes solver in order to compute compressible turbulent flows on fully unstructured meshes. Solutions about single and multiple element airfoils are obtained and compared with experimental data. Author

**N90-23677#** Johns Hopkins Univ., Baltimore, MD.
**NUMERICAL AND PHYSICAL MODELLING OF BUBBLY FLOW PHENOMENA Progress Report, 1 Jul. 1989 - 31 Mar. 1990**
A. Prosperetti and A. S. Sangani (Syracuse Univ., NY.) Mar. 1990 25 p
(Contract DE-FG02-89ER-14043)
(DE90-009837; DOE/ER-14043/1) Avail: NTIS HC A03/MF A01

The ulitmate purpose is to put the widely used engineering averaged-equations models of multiphase flows on a firmer footing by comparing their results with those of direct numerical multiparticle simulations and rigorously-derived averaged equations. Since the averaged-equations models are comparatively well developed, in the first year of this project the focus was on the multiparticle simulation and ensemble averaging techniques. The progress to date is described for the several problems that are being studied. The first problem addresses the derivation of ensemble-averaged equations for the propagation of pressure waves in bubbly liquids. The result is in the form of an expansion for small gas volume fraction. Previously known results are recovered at first order and in certain limits at higher order. However, a new insight into the structure of the expansion and the role of bubble-bubble interaction and surface deformations is obtained from this work. DOE

**N90-23678*#** Institute for Computer Applications in Science and Engineering, Hampton, VA.
**THE STABILITY OF TWO-DIMENSIONAL WAKES AND SHEAR-LAYERS AT HIGH MACH NUMBERS Final Report**
D. T. Papageorgiou (City Coll. of the City Univ. of New York, NY.) May 1990 27 p Submitted for publication
(Contract NAS1-18605)
(NASA-CR-182050; NAS 1.26:182050; ICASE-90-39) Avail: NTIS HC A03/MF A01 CSCL 20D

The stability properties were studied of laminar free shear-layer flows, and in particular symmetric 2-D wakes, for the subsonic through the hypersonic regime. Emphasis is given to the use of proper wake profiles that satisfy the equations of motion at high Reynolds numbers. In particular, the inviscid stability of a developing 2-D wake as it accelerates at the trailing edge of a splitter plate was studied. The non-parallelism of the flow is a leading order effect, and the undisturbed state is solved numerically. The neutral stability characteristics are computed numerically and the hypersonic stability is obtained by increasing the Mach number. It is found that the neutral stability characteristics are altered significantly as the wake develops. Multiple modes (second modes) are found in the near-wake (they are shown to be closely related to the corresponding Blasius ones), but as the wake develops, mode multiplicity is delayed to higher and higher Mach numbers. At a distance of about one plate length from the trailing edge, there is only one mode in a Mach number range of zero to twenty. The dominant mode emerging at all wake stations and for high enough Mach numbers is the so-called vorticity mode, which is centered around the generalized inflection point layer. The structure of the dominant mode is also obtained analytically for all streamwise wake locations and it is shown how the far-wake limit is approached. Asymptotic results for the hypersonic mixing layer given by a tanh and a Lock distribution are also given. Author

**N90-23679*#** Fermi National Accelerator Lab., Batavia, IL. Astrophysics Center.
**THE DYNAMIC INSTABILITY OF ADIABATIC BLASTWAVES**
Dongsu Ryu and Ethan T. Vishniac (Texas Univ., Austin.) May 1990 39 p Submitted for publication Sponsored in part by DOE
(Grant NAGw-1340)
(NASA-CR-182498; NAS 1.26:182498; FERMILAB-Pub-90/111-A) Avail: NTIS HC A03/MF A01 CSCL 20D

Adiabatic blastwaves, which have a total energy injected from the center E varies as t(sup q) and propagate through a preshock medium with a density rho(sub E) varies as r(sup -omega) are described by a family of similarity solutions. Previous work has shown that adiabatic blastwaves with increasing or constant postshock entropy behind the shock front are susceptible to an oscillatory instability, caused by the difference between the nature of the forces on the two sides of the dense shell behind the shock front. This instability sets in if the dense postshock layer is sufficiently thin. The stability of adiabatic blastwaves with a decreasing postshock entropy is considered. Such blastwaves, if they are decelerating, always have a region behind the shock front which is subject to convection. Some accelerating blastwaves also have such region, depending on the values of q, omega, and gamma where gamma is the adiabatic index. However, since the shock interface stabilizes dynamically induced perturbations, blastwaves become convectively unstable only if the convective zone is localized around the origin or a contact discontinuity far

with strong transverse strain. For this reason, it is hypothesized that a three-dimensional boundary layer is more prone to separate than is a two dimensional boundary layer, although it could not be proven here. Turbulence modeling of this flow revealed the strengths and weaknesses of several models. Dissert. Abstr.

**N90-23670*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**AERODYNAMIC PRESSURE AND HEATING-RATE DISTRIBUTIONS IN TILE GAPS AROUND CHINE REGIONS WITH PRESSURE GRADIENTS AT A MACH NUMBER OF 6.6**
L. Roane Hunt and Kristopher K. Notestine (PRC Kentron, Inc., Hampton, VA.) Washington Jun. 1990 70 p
(NASA-TP-2988; L-16649; NAS 1.60:2988) Avail: NTIS HC A04/MF A01 CSCL 20D

Surface and gap pressures and heating-rate distributions were obtained for simulated Thermal Protection System (TPS) tile arrays on the curved surface test apparatus of the Langley 8-Foot High Temperature Tunnel at Mach 6.6. The results indicated that the chine gap pressures varied inversely with gap width because larger gap widths allowed greater venting from the gap to the lower model side pressures. Lower gap pressures caused greater flow ingress from the surface and increased gap heating. Generally, gap heating was greater in the longitudinal gaps than in the circumferential gaps. Gap heating decreased with increasing gap depth. Circumferential gap heating at the mid-depth was generally less than about 10 percent of the external surface value. Gap heating was most severe at local T-gap junctions and tile-to-tile forward-facing steps that caused the greatest heating from flow impingement. The use of flow stoppers at discrete locations reduced heating from flow impingement. The use of flow stoppers at discrete locations reduced heating in most gaps but increased heating in others. Limited use of flow stoppers or gap filler in longitudinal gaps could reduce gap heating in open circumferential gaps in regions of high surface pressure gradients. Author

**N90-23671#** Catholic Univ. of America, Washington, DC.
**ADVANCED INSTRUMENTATION FOR LOCAL MEASUREMENT OF GAS-SOLID SUSPENSION FLOWS Quarterly Technical Report No. 11**
S. C. Ling and H. P. Pao 1990 5 p
(Contract DE-FG22-86PC-90956)
(DE90-008498; DOE/PC-90956/T9) Avail: NTIS HC A01/MF A01

An advanced optical technique was developed for the measurement of suspended-solid flows. This optical technique permits detailed experimental observation and analyses on the mechanics of sedimentary flows. The existence of microhairpin vortices as a major mechanism for the lifting of solid particles from the bottom flow boundary was identified and reported. A computational effort to study the detailed behavior of the microhairpin vortices was initiated. The purpose of this computational study is to follow in detail the evolution of the three-dimensional hairpin vortices in the boundary layer, and to investigate the roles of these vortices on the lifting mechanisms of solid particles by the strong suction provided by these intense micro-vortices. Author

**N90-23672** Arizona Univ., Tucson.
**NUMERICAL STUDY OF THE ONSET OF INSTABILITY IN THE FLOW PAST A SPHERE Ph.D. Thesis**
Inchul Kim 1989 128 p
Avail: Univ. Microfilms Order No. DA9003490

Experiment shows that the steady axisymmetric flow past a sphere becomes unstable in the range 120 less than Re less than 300. The resulting time-dependent nonaxisymmetric flow gives rise to nonaxisymmetric vortex shedding at higher Reynolds numbers. A computational investigation of the linear stability of the axisymmetric base flow is reported. When the sphere is towed, fixed, or otherwise constrained, stability is determined solely by the Reynolds number. On the other hand, when the sphere falls due to gravity, an additional parameter, the ratio of fluid density to sphere density (beta = rho(f)/rho(s)) is involved. A spectral technique is used to compute the steady axisymmetric flow, which is in closer agreement with experiment than previous calculations. A linear stability analysis of the base flow is performed with respect to axisymmetric and nonaxisymmetric disturbances. A spectral technique similar to that employed in the base flow calculation is used to solve the linear disturbance equations in streamfunction form for axisymmetric form for disturbances, and in a modified primitive variable form for nonaxisymmetric disturbances. For the density ratio beta = 0, which corresponds to a fixed sphere, the analysis shows that the axisymmetric base flow undergoes a Hopf bifurcation at Re = 175.1, with the critical disturbance having azimuthal wavenumber m = 1. The results are favorably compared to previous experimental work. Dissert. Abstr.

**N90-23673** Connecticut Univ., Storrs.
**COMPUTATIONS OF A HORSESHOE VORTEX AROUND AN ENDWALL-MOUNTED CYLINDER Ph.D. Thesis**
Craig Allen Wagner 1989 258 p
Avail: Univ. Microfilms Order No. DA9003836

Numerical predictions of the horseshoe vortex formed around an endwall mounted cylinder, using the Reynolds averaged, steady, incompressible Navier-Stokes equations, are compared to experimental measurements. The flow is fully turbulent with a Reynolds number of 550,000 based on inlet velocity and cylinder diameter. An existing computer code, INS3D, was originally applied to compute this flow field. Difficulties associated with the convergence and accuracy of this code for predicting this class of flows required the development and implementation of algorithmic improvements. Discussions of the extensive modifications made and improved accuracy and convergence characteristics, which resulted in the NAV3D computer code, are given. Two dimensional test cases and laminar flow around an endwall mounted cylinder are used to show the enhanced capability. The implementation and validation of an algebraic eddy viscosity model and k-epsilon model for turbulent flow are discussed. Difficulties associated with applying each model to the endwall cylinder flow allowed only the algebraic eddy viscosity model to be used. These difficulties are examined. For the case using the simple eddy viscosity model, two different size meshes were used. One mesh contains 265,320 points and the other has 442,200 points. Each solution is compared to experimental data with discussions on the degree of correlation. Suggestions are given for improving the accuracy of the solution in areas of poor correlation. Dissert. Abstr.

**N90-23674*#** Arizona Univ., Tucson. Dept. of Aerospace and Mechanical Engineering.
**NONLINEAR INTERACTIONS IN MIXING LAYERS AND COMPRESSIBLE HEATED ROUND JETS Ph.D. Thesis Final Report**
Yousef Mohd Jarrah 1989 171 p
(Grant NAG3-485)
(NASA-CR-186303; NAS 1.26:186303) Avail: NTIS HC A08/MF A01 CSCL 20D

The nonlinear interactions between a fundamental instability mode and both its harmonics and the changing mean flow are studied using the weakly nonlinear stability theory of Stuart and Watson, and numerical solutions of coupled nonlinear partial differential equations. The first part focuses on incompressible cold (or isothermal; constant temperature throughout) mixing layers, and for these, the first and second Landau constants are calculated as functions of wavenumber and Reynolds number. It is found that the dominant contribution to the Landau constants arises from the mean flow changes and not from the higher harmonics. In order to establish the range of validity of the weakly nonlinear theory, the weakly nonlinear and numerical solutions are compared and the limitation of each is discussed. At small amplitudes and at low-to-moderate Reynolds numbers, the two results compare well in describing the saturation of the fundamental, the distortion of the mean flow, and the initial stages of vorticity roll-up. At larger amplitudes, the interaction between the fundamental, second harmonic, and the mean flow is strongly nonlinear and the numerical solution predicts flow oscillations, whereas the weakly nonlinear

theory yields saturation. In the second part, the weakly nonlinear theory is extended to heated (or nonisothermal; mean temperature distribution) subsonic round jets where quadratic and cubic nonlinear interactions are present, and the Landau constants also depend on jet temperature ratio, Mach number and azimuthal mode number. Under exponential growth and nonlinear saturation, it is found that heating and compressibility suppress the growth of instability waves, that the first azimuthal mode is the dominant instability mode, and that the weakly nonlinear solution describes the early stages of the roll-up of an axisymmetric shear layer. The receptivity of a typical jet flow to pulse type input disturbance is also studied by solving the initial value problem and then examining the behavior of the long-time solution. Author

**N90-23675*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**EQUILIBRIUM RADIATIVE HEATING TABLES FOR EARTH ENTRY**
Kenneth Sutton and Lin C. Hartung May 1990 28 p
(NASA-TM-102652; NAS 1.15:102652) Avail: NTIS HC A03/MF A01 CSCL 20D

The recent resurgence of interest in blunt-body atmospheric entry for applications such as aeroassisted orbital transfer and planetary return has engendered a corresponding revival of interest in radiative heating. Radiative heating may be of importance in these blunt-body flows because of the highly energetic shock layer around the blunt nose. Sutton developed an inviscid, stagnation point, radiation coupled flow field code for investigating blunt-body atmospheric entry. The method has been compared with ground-based and flight data, and reasonable agreement has been found. To provide information for entry body studies in support of lunar and Mars return scenarios of interest in the 1970's, the code was exercised over a matrix of Earth entry conditions. Recently, this matrix was extended slightly to reflect entry vehicle designs of current interest. Complete results are presented. Author

**N90-23676*#** Institute for Computer Applications in Science and Engineering, Hampton, VA.
**ALGEBRAIC TURBULENCE MODELING FOR UNSTRUCTURED AND ADAPTIVE MESHES Final Report**
Dimitri J. Mavriplis May 1990 31 p Submitted for publication
(Contract NAS1-18605)
(NASA-CR-182035; NAS 1.26:182035; ICASE-90-30) Avail: NTIS HC A03/MF A01 CSCL 20D

An algebraic turbulence model based on the Baldwin-Lomax model, was implemented for use on unstructured grids. The implementation is based on the use of local background structured turbulence meshes. At each time-step, flow variables are interpolated from the unstructured mesh onto the background structured meshes, and the resulting eddy viscosity values are interpolated back to the unstructured mesh. Modifications to the algebraic model were required to enable the treatment of more complicated flows, such as confluent boundary layers and wakes. The model is used in conjunction with an efficient unstructured multigrid finite-element Navier-Stokes solver in order to compute compressible turbulent flows on fully unstructured meshes. Solutions about single and multiple element airfoils are obtained and compared with experimental data. Author

**N90-23677#** Johns Hopkins Univ., Baltimore, MD.
**NUMERICAL AND PHYSICAL MODELLING OF BUBBLY FLOW PHENOMENA Progress Report, 1 Jul. 1989 - 31 Mar. 1990**
A. Prosperetti and A. S. Sangani (Syracuse Univ., NY.) Mar. 1990 25 p
(Contract DE-FG02-89ER-14043)
(DE90-009837; DOE/ER-14043/1) Avail: NTIS HC A03/MF A01

The ulitmate purpose is to put the widely used engineering averaged-equations models of multiphase flows on a firmer footing by comparing their results with those of direct numerical multiparticle simulations and rigorously-derived averaged equations. Since the averaged-equations models are comparatively well developed, in the first year of this project the focus was on the multiparticle simulation and ensemble averaging techniques. The progress to date is described for the several problems that are being studied. The first problem addresses the derivation of ensemble-averaged equations for the propagation of pressure waves in bubbly liquids. The result is in the form of an expansion for small gas volume fraction. Previously known results are recovered at first order and in certain limits at higher order. However, a new insight into the structure of the expansion and the role of bubble-bubble interaction and surface deformations is obtained from this work. DOE

**N90-23678*#** Institute for Computer Applications in Science and Engineering, Hampton, VA.
**THE STABILITY OF TWO-DIMENSIONAL WAKES AND SHEAR-LAYERS AT HIGH MACH NUMBERS Final Report**
D. T. Papageorgiou (City Coll. of the City Univ. of New York, NY.) May 1990 27 p Submitted for publication
(Contract NAS1-18605)
(NASA-CR-182050; NAS 1.26:182050; ICASE-90-39) Avail: NTIS HC A03/MF A01 CSCL 20D

The stability properties were studied of laminar free shear-layer flows, and in particular symmetric 2-D wakes, for the subsonic through the hypersonic regime. Emphasis is given to the use of proper wake profiles that satisfy the equations of motion at high Reynolds numbers. In particular, the inviscid stability of a developing 2-D wake as it accelerates at the trailing edge of a splitter plate was studied. The non-parallelism of the flow is a leading order effect, and the undisturbed state is solved numerically. The neutral stability characteristics are computed numerically and the hypersonic stability is obtained by increasing the Mach number. It is found that the neutral stability characteristics are altered significantly as the wake develops. Multiple modes (second modes) are found in the near-wake (they are shown to be closely related to the corresponding Blasius ones), but as the wake develops, mode multiplicity is delayed to higher and higher Mach numbers. At a distance of about one plate length from the trailing edge, there is only one mode in a Mach number range of zero to twenty. The dominant mode emerging at all wake stations and for high enough Mach numbers is the so-called vorticity mode, which is centered around the generalized inflection point layer. The structure of the dominant mode is also obtained analytically for all streamwise wake locations and it is shown how the far-wake limit is approached. Asymptotic results for the hypersonic mixing layer given by a tanh and a Lock distribution are also given. Author

**N90-23679*#** Fermi National Accelerator Lab., Batavia, IL. Astrophysics Center.
**THE DYNAMIC INSTABILITY OF ADIABATIC BLASTWAVES**
Dongsu Ryu and Ethan T. Vishniac (Texas Univ., Austin.) May 1990 39 p Submitted for publication Sponsored in part by DOE
(Grant NAGw-1340)
(NASA-CR-182498; NAS 1.26:182498; FERMILAB-Pub-90/111-A) Avail: NTIS HC A03/MF A01 CSCL 20D

Adiabatic blastwaves, which have a total energy injected from the center E varies as t(sup q) and propagate through a preshock medium with a density rho(sub E) varies as r(sup -omega) are described by a family of similarity solutions. Previous work has shown that adiabatic blastwaves with increasing or constant postshock entropy behind the shock front are susceptible to an oscillatory instability, caused by the difference between the nature of the forces on the two sides of the dense shell behind the shock front. This instability sets in if the dense postshock layer is sufficiently thin. The stability of adiabatic blastwaves with a decreasing postshock entropy is considered. Such blastwaves, if they are decelerating, always have a region behind the shock front which is subject to convection. Some accelerating blastwaves also have such region, depending on the values of q, omega, and gamma where gamma is the adiabatic index. However, since the shock interface stabilizes dynamically induced perturbations, blastwaves become convectively unstable only if the convective zone is localized around the origin or a contact discontinuity far

from the shock front. On the other hand, the contact discontinuity of accelerating blastwaves is subject to a strong Rayleigh-Taylor instability. The frequency spectra of the nonradial, normal modes of adiabatic blastwaves have been calculated. The results have been applied to the shocks propagating through supernovae envelopes. It is shown that the metal/He and He/H interfaces are strongly unstable against the Rayleigh-Taylor instability. This instability will induce mixing in supernovae envelopes. In addition the implications of this work for the evolution of planetary nebulae is discussed. Author

**N90-23680#** Massachusetts Inst. of Tech., Cambridge. Gas Turbine Lab.
**UNSTEADY FLOW PHENOMENA IN TURBOMACHINES Final Technical Report, 19 Oct. 1987 - 18 Oct. 1989**
Edward M. Greitzer, Alan H. Epstein, Michael B. Giles, James E. McCune, and Choon S. Tan 24 Jan. 1990 195 p
(Contract F49620-85-C-0018; AF Proj. 2307)
(AD-A218370; AFOSR-90-0217TR) Avail: NTIS HC A09/MF A02 CSCL 20/4

Work carried out at the Gas Turbine Laboratory at M.I.T. as part of the multi-investigator effort on basic unsteady flow phenomena is described. Within the overall project, four separate tasks are specified. These are, in brief: unsteady flow in compressors; computational techniques for unsteady flows; unsteady phenomena, inlet distortion, and flow instabilities in multistage compressors; and unsteady vortical wakes behind blade rows - prediction of relationships with blade properties. GRA

**N90-23681#** Naval Postgraduate School, Monterey, CA. Dept. of Mechanical Engineering.
**NATURAL CONVECTION LIQUID IMMERSION COOLING OF HIGH DENSITY COLUMNS OF DISCRETE HEAT SOURCES IN A VERTICAL CHANNEL M.S. Thesis**
Alfred O. Gaiser Jun. 1989 130 p
(AD-A218388) Avail: NTIS HC A07/MF A01 CSCL 13/1

Natural convection liquid cooling of simulated electronic components in a vertical channel was investigated. The test surface consisted of three columns of fifteen flush mounted foil heaters. The channel was formed by placing a smooth movable shrouding wall parallel to the test surface. The experimental procedure called for temperature measurements and flow visualization at various power levels and channel spacings. Surface temperatures of each heat source were measured using a centrally located embedded thermocouple. Temperature measurement within the flow was conducted using a thermocouple probe. Flow visualization was conducted with the use of a laser generated plane of light. A visual temperature profile of the board was developed through the use of liquid crystals. From the data obtained, experimental correlations relating the local heat transfer properties with shroud wall spacing and strip heater power levels were developed. GRA

**N90-23682#** Naval Postgraduate School, Monterey, CA. Dept. of Aeronautics and Astronautics.
**DETERMINATION OF THE VELOCITY, DENSITY, MAXIMUM FLUX, AND ENTHALPY PROFILES FOR A VERY HIGH TEMPERATURE ARC JET NOZZLE FLOW M.S. Thesis**
Robert William Kopp Jun. 1989 63 p
(AD-A218390) Avail: NTIS HC A04/MF A01 CSCL 20/4

Hypervelocity flows for velocities is excess of 1.4 km/sec (Mach 5) require very high stagnation temperature to avoid liquefaction. The arc heater wind tunnel was designed to provide such flows. The electric-arc driven wind tunnel can develop stagnation temperatures up to 13,000 K which will produce hypervelocity flows up to 7 km/sec (earth orbital speed). The nature of the flow, however, is such that the high temperature source flow may cause severe gradients at the nozzle exit. In order to perform aerothermodynamic tests the characterization of the flow in the test section is required. This paper experimentally determines the stream profiles for an arcjet wind tunnel conical nozzle directly from calorimetry and pitot probe surveys. GRA

**N90-23683*#** Stanford Univ., CA. Dept. of Mechanical Engineering.
**TOPOLOGY OF THREE-DIMENSIONAL, VARIABLE DENSITY FLOWS**
Brian Cantwel, Gregory Lewis, and Jacqueline Chen (Sandia National Labs., Livermore, CA.) Dec. 1989 7 p Presented at the 10th Australasian Fluid Mechanics Conference, Melbourne, Australia, Dec. 1989 Sponsored by NASA, Ames Research Center
(Contract DE-AC04-76DP-00789; AF-AFOSR-0373-84; AF Proj. 2308)
(NASA-CR-186622; NAS 1.26:186622; AD-A218469; AFOSR-90-0181TR) Avail: NTIS HC A02/MF A01 CSCL 20/4

This paper is concerned with the interpretation of unsteady, variable-density flow fields. The topology of the flow is determined by finding critical points and identifying the character of local solution trajectories. The time evolution of the flow is studied by following the paths of the critical points in the three-dimensional space of invariants of the local deformations tensor. The methodology can be applied to any smooth vector field and its associated gradient tensor including the vorticity and pressure gradient fields. This approach provides a framework for describing the geometry of complex flow patterns. Concisely summarizing that geometry in the space of invariants of the local gradient tensor may be a useful way of gaining insight into time-dependent processes described by large computational data bases. Applications to the descriptions of a flickering diffusion flame and a compressible wake are discussed. GRA

**N90-23684#** Materials Research Labs., Ascot Vale (Australia).
**NUMERICAL MODELLING OF SHOCKS IN GASES AND METALS**
Moya B. Tyndall Maribyrnong, Australia 1989 51 p
(AD-A218586; MRL-RR-8-89; DODA-AR-005-742) Avail: NTIS HC A04/MF A01 CSCL 20/4

Results are presented for a range of one-dimensional shock wave problems in gaseous and metallic materials. These problems were solved numerically using Flux-Corrected Transport (FCT). FCT is a numerical technique which achieves high resolution without non-physical oscillations, especially in regions of steep gradients such as shock fronts. These types of problem involve solving the Eulerian inviscid fluid flow equations, namely the continuity equation, conservation of momentum and conservation of energy, with an appropriate equation of state. For gaseous materials the ideal gas equation of state was used and for metallic materials the stiffened-gas or the Mie-Gruneisen equation of state. Shock wave problems in gases included the one-dimensional shock tube problem, a shock wave hitting a density discontinuity and shocks of equal magnitude colliding. Using the stiffened-gas equation of state and the Mie-Gruneisen equation of state similar types of problems were solved for metallic materials, for example, a shock propagating through a piece of metal. A discussion of the performance of FCT to accurately model these problems is given. Currently work is being done on adding elastic-plastic (or viscous) terms and heat conduction terms to the fluid flow equations, to improve the description of flow in a solid material. GRA

**N90-23685#** Department of the Navy, Washington, DC.
**FAST GRID GENERATION Patent Application**
Stephen Jordan, inventor (to Navy) 31 Oct. 1989 20 p
(AD-D014454; US-Patent-Appl-SN-432108) Avail: NTIS HC A03/MF A01 CSCL 20/4

This patent application discloses a method for a fast and efficient grid generation to study the interaction of a moving body with a fluid in which it is traveling. The method includes setting up a grid including the grid generating equations based upon the flow equations in the fluid flow domain of interest. The grid generating equations are solved numerically using Newton's method and modified strongly implicit (MSI) method by going through a series of iterations determined by the thresholds on the error functions involved. GRA

**N90-23686#** Pittsburgh Univ., PA. Dept. of Mathematics and Statistics.
**COMPUTATIONAL FLUID DYNAMICS Final Report, 1 Aug. 1988 - 30 Nov. 1989**
Charles A. Hall and Thomas A. Porsching 31 Jan. 1990 38 p
(Grant AF-AFOSR-0262-88; AF Proj. 2304)
(AD-A219557; AFOSR-90-0306TR) Avail: NTIS HC A03/MF A01 CSCL 20/4

The general area of computational fluid dynamics was studied. Topics include the dual variable method, Differential Algebraic Equation, the reduced basis method, divergence free finite elements, diffusive-transport systems, and bifurcation phenomena. Short descriptions of these projects are included, along with references to published reports. GRA

**N90-23687#** Cincinnati Univ., OH. Dept. of Aerospace Engineering Engineering Mechanics.
**COMPOSITE REDUCED NAVIER STOKES PROCEDURES FOR FLOW PROBLEMS WITH STRONG PRESSURE INTERACTIONS Final Report, 1 Feb. 1985 - 31 Oct. 1989**
S. G. Rubin and P. K. Khosla 30 Jan. 1990 41 p
(Contract F49620-85-C-0027; AF Proj. 2307)
(AD-A219621; AFOSR-90-0296TR) Avail: NTIS HC A03/MF A01 CSCL 20/4

The Reduced Navier Stokes (RNS) formulation for viscous-inviscid interacting flows with significant upstream or elliptic effects was applied for transient flow over airfoils at incidence, and steady 2-D and 3-D flows over cavity, wing and afterbody configurations. The solution technique applies uniformly over the entire Mach number range and allows for shock boundary layer interaction, and for moderate regions of axial and secondary flow recirculation. For 2-D problems with recirculation, it was demonstrated that for laminar flows there exists a critical Reynolds number, that is geometry dependent, above which the solution exhibits a breakdown. This occurs in the region of recirculation and very close to the reattachment point. This phenomena is grid dependent and can be missed with insufficiently refined grids or when artificial viscosity is introduced. It was shown that the pressure-split RNS procedure is in fact a special form of flux vector splitting that has very favorable properties for sharp shock capturing. A sparse matrix direct solver procedure has been applied for both two-dimensional transient flows, and for three-dimensional steady flows with the RNS flux-split strategy. A uni-directional or semi-coarsening multigrid procedure has been further developed for viscous interacting flows, where significant grid stretching is required in order to adequately evaluate both thin viscous layers and large inviscid regions, with and without shock interaction. GRA

**N90-23688#** New York Univ., New York. Inst. of Mathematical Sciences.
**CENTER FOR ANALYSIS OF HETEROGENEOUS AND NONLINEAR MEDIA Final Report, 15 Sep. 1986 - 14 Oct. 1989**
Russell E. Caflisch 14 Oct. 1989 87 p
(Grant AF-AFOSR-0352-86; AF Proj. 3484)
(AD-A219627; AFOSR-90-0302TR) Avail: NTIS HC A05/MF A01 CSCL 20/4

The Center for Analysis of Heterogeneous and Nonlinear Media was established in October 1986 through the University Research Initiative (URI) Program. The scientific research of the Center has consisted of modeling, mathematical analysis and computation of problems in composite and random materials, nonlinear optics and fluid dynamics. The results of this research are presented in a number of research publications and several books. Two workshops, on vortex dynamics and on composite materials, were organized by the Center. The focus of the Center has been on the following research areas: Vortex dynamics in incompressible fluids; Numerical methods for fluid dynamics; Macroscopic properties of composite materials; Wave propagation in random media; and Nonlinear phenomena in optical materials. GRA

**N90-23689#** Illinois Univ. at Urbana-Champaign, Savoy. Gas Dynamics Lab.
**FLUID DYNAMIC MECHANISMS AND INTERACTIONS WITHIN SEPARATED FLOWS Final Technical Report, 1 Dec. 1986 - 30 Nov. 1989**
J. C. Dutton and A. L. Addy 15 Feb. 1990 161 p
(Contract DAAL03-87-K-0010)
(AD-A219628; UIUC-ENG-90-4001; ARO-24139.12-EG) Avail: NTIS HC A08/MF A01 CSCL 20/4

The significant results of a joint research effort investigating the fundamental fluid dynamic mechanisms and interactions within high-speed separated flows are presented in detail. The results have obtained through analytical and numerical approaches, but with primary emphasis on experimental investigations of missile and projectile base flow-related configurations. The objectives of the research program focus on understanding the component mechanisms and interactions which establish and maintain high-speed separated flow regions. The analytical and numerical efforts have centered on unsteady plume-wall interactions in rocket launch tubes and on predictions of the effects of base bleed on transonic and supersonic base flowfields. The experimental efforts have considered the development and use of a state-of-the-art two component laser Doppler velocimeter (LDV) system for experiments with planar, two-dimensional, small-scale models in supersonic flows. The LDV experiments have yielded high quality, well documented mean and turbulence velocity data for a variety of high-speed separated flows including initial shear layer development, recompression/reattachment processes for two supersonic shear layers, oblique shock wave/turbulent boundary layer interactions in a compression corner, and two-stream, supersonic, near-wake flow behind a finite-thickness base. GRA

**N90-23690#** Air Force Armament Lab., Eglin AFB, FL.
**THIN-LAYER NAVIER-STOKES SOLUTIONS OF THE ASYMMETRIC VORTICAL FLOW ON A TANGENT OGIVE BODY Report, Jan. - Sep. 1989**
Kirk J. Vanden Mar. 1990 103 p
(AD-A220810; AFATL-TP-90-04) Avail: NTIS HC A06/MF A01 CSCL 20/4

Laminar solutions for asymmetric vortical flow on a five caliber tangent ogive with an eight caliber cylindrical afterbody were calculated with a thin-layer Navier-Stokes code on a one block algebraic grid. Solutions were obtained for Mach 1.4 at 25, 30, 37.5, 38.5 and 40 deg angle of attack. The Reynolds number for all cases was 200,000 based on maximum body diameter. Two-dimensional particle traces in cross-sections of the flow and the limiting streamlines were calculated from the solutions. Validity of the thin-layer approximation in the flow field far away from the boundary layer was studied by recomputing the 37.5 deg case with the viscosity turned off at a distance away from the body. The solution was not significantly different, indicating that the outer vortex flow is basically inviscid. Both symmetric and asymmetric cases were calculated and analyzed. Secondary flow was shown in detail. Secondary flow increased with angle of attack. Crossflow topology diagrams were given in detail for symmetric and asymmetric conditions to illustrate the fundamental difference between these conditions. According to this research, asymmetry was characterized by the change in the topological structure near the saddle point associated with the primary vortices. Creation of vortex, by pinching of another vortex, was found to occur. This phenomenon was observed in both primary and secondary flow. GRA

**N90-23691#** Centro Italiano Ricerche Aerospaziali, Naples. Aerothermodynamics Section.
**ON UPWIND FORMULATIONS AND NON EQUILIBRIUM CHEMISTRY**
S. Borrelli 24 May 1989 34 p Short communication presented at VKI, Rhode Saint Genese, Belgium, 12 May 1989
(DLC/FLU-INT-TN-014; ETN-90-96559) Avail: NTIS HC A03/MF A01

Euler modelization of the flux and discontinuities and nonequilibrium chemistry for the relaxation of the species are

addressed. An extension of Osher like solver to non equilibrium chemistry is presented. Different upwind formulations are proposed. Attention is focused on coupling fluid dynamics and chemistry using finite rate equations. The flow was modeled using Euler equations and a simplified chemical model (air, 5 species, 17 reactions). ESA

**N90-23692#** Von Karman Inst. for Fluid Dynamics, Rhode-Saint-Genese (Belgium).
**SOLUTION OF THE STEADY STATE INCOMPRESSIBLE NAVIER-STOKES EQUATIONS AT HIGH REYNOLDS NUMBERS**
C. Benocci and K. Ruddick Jul. 1989 44 p
(VKI-TN-170; ETN-90-96573) Avail: NTIS HC A03/MF A01

The development and optimization of an implicit, finite differences solver for the incompressible steady state Navier-Stokes equations is described. Choices for the best correction procedure to enforce mass conservation, the most efficient solver for the pressure equation and the optimal time step for fast convergence are discussed and results of their comparison given. The resulting code is shown to be computationally robust and able to solve efficiently complex laminar flows at Reynolds numbers up to 1000. Its range of applicability can be further extended by the addition of artificial damping. ESA

**N90-23693#** Von Karman Inst. for Fluid Dynamics, Rhode-Saint-Genese (Belgium).
**LARGE EDDY SIMULATION OF A FULLY TURBULENT PLANE CHANNEL FLOW**
A Pinelli and C. Benocci Oct. 1989 58 p
(VKI-TN-171; ETN-90-96574) Avail: NTIS HC A04/MF A01

The development of a code for the large eddy simulation of wall bounded turbulent shear layers is described. The numerical approach selected is a finite difference discretization of the filtered Navier-Stokes equations, where the unresolved part of the turbulence is introduced through the Smagorinsky model of subgrid viscosity. A systematic study of the influence of mesh resolution, wall boundary condition and formulation of the advection term was performed for the case of a fully turbulent plane channel flow. ESA

**N90-23694#** Aerospatiale, Les Mureaux (France).
**BOUNDARY CONDITIONS FOR NONLINEAR HYPERBOLIC SYSTEMS OF CONSERVATION LAWS**
Francois Dubois and Philippe LeFloch (Ecole Polytechnique, Palaiseau, France ) 23 Jun. 1988 10 p Presented at the 2nd International Conference on Hyperbolic Problems, Aachen, Fed. Republic of Germany, 1988
(Rept-892-422-101; ETN-90-96626) Avail: NTIS HC A02/MF A01

Two formulations of the boundary conditions for nonlinear hyperbolic systems of conversation laws are proposed. A first approach is based on the vanishing viscosity method and a second one is related to the Riemann problem. The equivalence between these two conditions is studied. The latter formulation is extended to treat numerically physically relevant boundary conditions. Monodimensional experiments are presented. ESA

**N90-23695#** Aerospatiale, Paris (France). Div. Systemes Strategiques et Spatiaux.
**LOW PRANDTL NUMBER CONVECTION IN A RECTANGULAR CAVITY WITH LONGITUDINAL THERMAL GRADIENT AND TRANSVERSE g-JITTERS**
Didier Thevenard and Hamda Ben Hadid 8 Jun. 1990 24 p Submitted for publication
(Contract ESA-7681/88)
(Rept-892-430-109; DMG-46/89; ETN-90-96640) Avail: NTIS HC A03/MF A01

An extensive study of convective flows in a rectangular, bidimensional cavity, totally filled with a low Prandtl number fluid, and subject to a longitudinal thermal gradient and to transverse g-jitters of various amplitudes and frequencies is presented. The fluid is shown to behave like a first-order system with low damping and the frequency threshold beyond which g-jitters have a diminished influence is found. An analytical solution for the streamfunction of the flow is derived; it shows a displacement of the maximum of the velocity profile near the walls of the cavity at very high frequencies. Numerical computations are performed with a finite differences code; good agreement between analytical and numerical is found. ESA

**N90-23696#** Technische Univ., Delft (Netherlands). Faculty of Technical Mathematics and Informatics.
**FLUID OSCILLATIONS IN AN OPEN, FLEXIBLE CONTAINER**
R. M. S. M. Schulkes 1989 27 p
(Rept-89-69; ISSN-0922-5641; ETN-90-96671) Copyright Avail: NTIS HC A03/MF A01

Normal oscillation modes of an incompressible fluid in an open container, part of the wall of which may be flexible are studied. The flexible part of the container wall is modeled by a membrane. The eigenfrequencies of an inviscid fluid in a flexible container are investigated. By analytical means, the eigenfrequencies of an inviscid fluid are shown to decrease when part of the rigid container wall is replaced by a membrane. The problem of viscous fluid oscillations in a flexible container is then studied numerically using the finite element technique. Two different types of eigenmodes are observed: free-surface oscillation modes and structural vibration modes. The dependence of the two modes on the Bond number (measure of the ratio of gravitational and tension forces) and the Reynolds number is investigated. ESA

**N90-23697#** Maryland Univ., Baltimore. Dept. of Mathematics.
**ON COMPUTING THE PRESSURE BY THE p VERSION OF THE FINITE ELEMENT METHOD FOR STOKES PROBLEM**
Soren Jensen 15 Feb. 1990 24 p
(Contracts N00014-87-K-0427; N00014-90-J-1238)
(AD-A219887) Avail: NTIS HC A03/MF A01 CSCL 20/4

This paper introduces and analyzes two ways of extracting the hydrostatic pressure when solving Stokes problem using the p version of the finite element method. When one uses a local H superscript 1 projection, we show that optimal rates of convergence for the pressure approximation is achieved. When the pressure is not in H superscript, or the value of the pressure is only needed at a few points, one may extract the pressure pointwise using e.g., a single layer potential recovery. Negative norm and interior estimates for the Stokes velocity are derived within the framework of the p version of the finite element method. GRA

**N90-23698#** Iowa Univ., Iowa City. Inst. of Hydraulic Research.
**ON THE PLANAR TRANSLATION OF TWO BODIES IN A UNIFORM FLOW**
Zhi Guo and Allen T. Chwang Mar. 1990 59 p
(Contract N00014-89-J-1581)
(AD-A220143; IIHR-337) Avail: NTIS HC A04/MF A01 CSCL 20/4

The general planar translation of two bodies of revolution through an inviscid and incompressible fluid is considered. The moving trajectories and the hydrodynamic interactions are computed based on the generalized Lagrange's equations of motion, including the effects of solid constraints, external forces in th plane of motion, and uniform steam in any direction parallel to the plane of motion. In relative coordinate system moving with the stream, the kinetic energy of the fluid is expressed as a function of six added masses due to motions parallel and perpendicular to the line joining the centers of a solid pair. The exact solution of added masses and their derivatives with respect to the separation around each body is developed for added masses and their derivatives due to the centroidal motion. These results are compared with the numerical solution of added masses computed by the boundary-integral method and the generalized Taylor's added-mass formula. The integral equations, in terms of surface source distributions on both surfaces; are carefully modified for obtaining accurate numerical solutions. Numerical results are given for several practical engineering problems. GRA

**N90-23699** Toronto Univ. (Ontario). Inst. for Aerospace Studies.
**NUMERICAL STUDY OF UNSTEADY FLOWS IN LARGE AIR-DRIVEN BLAST SIMULATORS WITH SINGLE AND MULTIPLE DRIVERS**
G. L. Petrini and J. J. Gottlieb Mar. 1990 90 p
(Grant OGPIN-013)
(UTIAS-334; ISSN-0082-5255) Copyright Avail: Issuing Activity

Large air-driven blast simulators have multiple drivers connected to a single channel with a test section of 50 sq m in cross-section and larger where full-scale or large military test objects are subjected to simulated blast waves. However, previous numerical analyses of unsteady blast flows in such facilities were done with the multiple drivers combined into a single composite driver with an area variation based on the sum of the multiple-driver areas. Numerical results are presented for the first time for the case when the unsteady flows in these multiple drivers are treated separately and then all joined together with a specially developed junction cell to continue the unsteady flow solution throughout the channel. These results are compared to numerical solutions obtained for equivalent blast simulators with single composite, conical and curved drivers, in order to identify and illustrate important differences in the two types of solutions, explain the origin and behavior of many secondary and tertiary shock and rarefaction waves superposed on the simulated blast wave, and assess the advantages of obtaining full multiple-driver solutions with the correct secondary and tertiary flow features. Author

**N90-23700*** National Aeronautics and Space Administration. Pasadena Office, CA.
**MULTI-ELEMENT SPHERICAL SHELL GENERATION Patent**
Andrew D. Morrison, inventor (to NASA) (Jet Propulsion Lab., California Inst. of Tech., Pasadena.) 20 Feb. 1990 7 p Filed 28 Sep. 1988 Supersedes N89-13728 (27 - 5, p 636)
(Contract NAS7-918)
(NASA-Case-NPO-17203-1-CU; US-Patent-4,902,450; US-Patent-Appl-SN-250195; US-Patent-Class-264-4; US-Patent-Class-425-5; US-Patent-Class-425-6; US-Patent-Class-425-804; Int-Patent-Class-B29B-9/10) Avail: US Patent and Trademark Office CSCL 20D

A nozzle assembly in a multi-element spherical shell generation system includes first and second side-by-side spaced apart nozzles and a web portion extending between and connecting the nozzles. The first nozzle has an inner orifice adapted to discharge a first filler material and an outer annular orifice separated from and defined in concentric relation about the inner orifice and adapted to discharge a first shell material. The second nozzle has an inner orifice adapted to discharge a second filler material and an outer annular orifice separated from and defined in concentric relation about the inner orifice and adapted to discharge a second shell material. A multi-element spherical shell can be formed through employment of the nozzle assembly by merger with one another after discharge from the outer orifices of the nozzles of a pair of adjacent annular streams of liquid or molten shell wall material of different compositions and encapsulation by the mixed shell wall materials of a common encapsulated core fluids also simultaneously discharged by the inner orifices nozzles. On the other hand, the pair of encapsulating streams of shell wall material can be of the same materials which merge together and encapsulate core fluids of different compositions which will merge together after discharge from the nozzles.
Official Gazette of the U.S. Patent and Trademark Office

**N90-23701*#** MCAT Inst., Moffett Field, CA.
**EXTRA COMPRESSIBILITY TERMS FOR FAVRE-AVERAGED TWO-EQUATION MODELS OF INHOMOGENEOUS TURBULENT FLOWS**
Morris W. Rubesin Jun. 1990 19 p
(Contract NCC2-585)
(NASA-CR-177556; A-90196; NAS 1.26:177556) Avail: NTIS HC A03/MF A01 CSCL 20D

Forms of extra-compressibility terms that result from use of Favre averaging of the turbulence transport equations for kinetic energy and dissipation are derived. These forms introduce three new modeling constants, a polytropic coefficient that defines the interrelationships of the pressure, density, and enthalpy fluctuations and two constants in the dissipation equation that account for the non-zero pressure-dilitation and mean pressure gradients. Author

**N90-23702#** Technische Hochschule, Aachen (Germany, F.R.). Inst. fuer Strahlantriebe und Turboarbeitsmachinen.
**A PROCESS FOR THE MEASUREMENT OF THE UNSTEADY THREE DIMENSIONAL STREAM VECTORS IN TURBOMACHINES [EIN VERFAHREN ZUR VERMESSUNG DER INSTATIONAEREN DREIDIMENSIONALEN STROEMUNGSVEKTOREN IN TURBOMASCHINEN]**
C. Poensgen Jul. 1989 53 p In GERMAN
(Mitt-89-01; ETN-90-96476) Avail: NTIS HC A04/MF A01

A calibration process for a thermal wire sonde is presented. It allows the measurement of the unsteady three dimensional stream field behind the rotor of a turbomachine for Mach numbers of up to 0.6. The turbulence structure is shown to be non-isotropic but depends on the intensity of the stochastic velocities. To describe the heat transfers, polynomials approximations were used. For the data evaluation, an online system with three processors allowed a data reduction: first the velocity fluctuations are evaluated and afterwards the stochastic velocity oscillations must be calculated. ESA

**N90-23703#** Ecole Centrale de Lyon (France).
**SECOND MOMENT MODELS OF TURBULENCE: COMPLEX OR STRATIFIED FLOW Ph.D. Thesis [MODELE DE TURBULENCE AU DEUXIEME ORDRE: ECOULEMENTS COMPLEXES OU STRATIFIES]**
Mohamed Kanniche 1990 143 p In FRENCH
(ECL-90-02; ETN-90-96937) Avail: NTIS HC A07/MF A01

Exact open equations used in analyzing turbulent flow are presented. The steps involved in deriving these equations are detailed. Second moment closure models are presented. The numeric methods used are described. Limiting conditions are discussed. The experimental results of sudden openings are presented. Stable and unstable stratification results are described. The statistical approach developed to solve the Navier-Stokes equations is shown to be useful. It gives satisfactory results in both strongly sheared and thermally stratified flow. ESA

**N90-23704#** Ecole Centrale de Lyon (France).
**MODELING TURBULENT FLOW WITH MIXED THERMAL CONVECTION TRANSFER Ph.D. Thesis [MODELISATION DES ECOULEMENTS TURBULENTS AVEC TRANSFERTS THERMIQUES EN CONVECTION MIXTE]**
Gilmar MompeanMunhozdaCruz 1989 234 p In FRENCH
Sponsored by Conselho Nacional de Pesquisas, Brazil, and Universidade Estadual de Campinas, Brazil
(ECL-89-19; ETN-90-96939) Avail: NTIS HC A11/MF A02

Second order models used in predicting turbulent flow involving thermal transfer are described. The models are based on step equations. Dimensional analysis of all the terms used in the equations is carried out using the large number hypothesis developed by Reynolds and Peclet. A two equation model is used for the hydrodynamic aspects of the problem. For thermal considerations a prt plus theta squared model and a complete model are developed. The steps involved in developing the two models are described in detail. ESA

# 35 INSTRUMENTATION AND PHOTOGRAPHY

Includes remote sensors; measuring instruments and gages; detectors; cameras and photographic supplies; and holography.

For aerial photography see *43 Earth Resources and Remote Sensing*. For related information see also *06 Aircraft Instrumentation*, and *19 Spacecraft Instrumentation*.

**N90-23705#** Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems.
**ISOPLANATIC SYSTEMS IN MESOOPTICS**
L. M. Soroko 18 Aug. 1989 12 p Presented at the Optoelectronics: Ernst Abbe Conference, Jena, German Democratic Republic, 21-26 Aug. 1989 Submitted for publication
(DE90-009785; JINR-D13-89-549; CONF-8908224-2) Avail: NTIS (US Sales Only) HC A03/MF A01

The problem of the coma aberration suppression in optics, holography, and mesooptics is discussed. A short review of the Abbe sine condition in the holography is given. Then the problem of the isoplanatic system construction in mesooptics is formulated. Its solution in the form of the generalized Abbe sine condition and the Welford theorem concerning the form of the hologram backing is presented. The designs of two isoplanatic mesooptical systems: the Mesooptical Fourier-Transform Microscope for nuclear research emulsion and the Mesooptical Axicon Objective for track chambers in the high energy physics are described. DOE

**N90-23706*** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**CIRCUMFERENTIAL PRESSURE PROBE Patent**
Harlan K. Holmes, inventor (to NASA), Thomas C. Moore, inventor (to NASA), and Andrew J. Fantl, inventor (to NASA) (Virginia Commonwealth Univ., Richmond.) 17 Oct. 1989 7 p Filed 23 Sep. 1988 Supersedes N89-14408 (27 - 6, p 757)
(NASA-Case-LAR-13775-1; US-Patent-4,873,990; US-Patent-Appl-SN-248020; US-Patent-Class-128-748; US-Patent-Class-128-675; US-Patent-Class-128-778; Int-Patent-Class-A61B-5/00) Avail: US Patent and Trademark Office CSCL 14B

A probe for measuring circumferential pressure inside a body cavity is disclosed. In the preferred embodiment, a urodynamic pressure measurement probe for evaluating human urinary sphincter function is disclosed. Along the length of the probe are disposed a multiplicity of deformable wall sensors which typically comprise support tube sections with flexible side wall areas. These are arranged along the length of the probe in two areas, one just proximal to the tip for the sensing of fluid pressure inside the bladder, and five in the sensing section which is positioned within the urethra at the point at which the urinary sphincter constricts to control the flow of urine. The remainder of the length of the probe comprises multiple rigid support tube sections interspersed with flexible support tube sections in the form of bellows to provide flexibility.

Official Gazette of the U.S. Patent and Trademark Office

**N90-23707*** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**MINIATURIZATION OF FLIGHT DEFLECTION MEASUREMENT SYSTEM Patent**
Robert Fodale, inventor (to NASA) and Herbert R. Hampton, inventor (to NASA) (Grumman Aerospace Corp., Bethpage, NY.) 30 Jan. 1990 6 p Filed 30 Sep. 1988
(NASA-Case-LAR-13628-1; US-Patent-4,896,533; US-Patent-Appl-SN-251438; US-Patent-Class-73-147; US-Patent-Class-340-825.69; Int-Patent-Class-G01M-9/00) Avail: US Patent and Trademark Office CSCL 14B

A flight deflection measurement system is disclosed including a hybrid microchip of a receiver/decoder. The hybrid microchip decoder is mounted piggy back on the miniaturized receiver and forms an integral unit therewith. The flight deflection measurement system employing the miniaturized receiver/decoder can be used in a wind tunnel. In particular, the miniaturized receiver/decoder can be employed in a spin measurement system due to its small size and can retain already established control surface actuation functions.

Official Gazette of the U.S. Patent and Trademark Office

**N90-23708#** Chicago Univ., IL. Dept. of Chemistry.
**INSTRUMENTATION FOR SURFACE REACTION DYNAMICS Final Technical Report, 1 Dec. 1988 - 30 Nov. 1989**
Steven J. Sibener 22 Jan. 1990 12 p
(Grant AF-AFOSR-0153-89; AF Proj. 3842)
(AD-A218608; AFOSR-90-0246TR) Avail: NTIS HC A03/MF A01 CSCL 07/4

This instrumentation grant was used to design and fabricate an intense neutral particle beamline for use in gas-surface collision experiments. The three-fold differentially pumped beamline is being used in conjunction with a new inelastic electron-surface scattering spectrometer in order to extend our studies of surface reactivity and gas-surface collision phenomena into many areas. New capabilities include the ability to examine surface reaction kinetics occurring on surfaces (as opposed to monitoring volatile reaction products), encounters between optically excited and translationally selected molecules and surfaces, gaseous condensation, and surface photochemistry. Future surface oxidation studies involving atomic reactants and radicals will also be possible pending construction of appropriate atomic/molecular nozzle beam sources. The instrumentation assembled under the auspices of this grant has directly enhanced research efforts. GRA

**N90-23709#** New Mexico Univ., Albuquerque.
**LASER GYROS AND FIELD DIAGNOSTICS Final Report**
J.-C. Diels Feb. 1990 20 p
(Contract N00014-87-K-0207)
(AD-A220832) Avail: NTIS HC A03/MF A01 CSCL 09/3

An investigation was conducted of two subjects: (1) New concepts of rotation sensing, and (2) New methods to time resolve electrical transients. Today's He-Ne laser gyro's have reached a ceiling in technical development, and dominate the inertial navigation market worldwide. Since the quantum noise limit of these lasers is approached, there is little room left for improvement. It is therefore appropriate to seek for alternate conceptions of laser gyros, rather than to attempt to push further the limits of an already nearly perfect technology. The goals to be seeked for the next generation of rotation sensors are: smaller size, all solid state, and reduced noise (hence, higher accuracy). GRA

**N90-23710#** Technische Univ., Delft (Netherlands).
**AN ELECTRONIC SPIRIT LEVEL TILT SENSOR Ph.D. Thesis**
Yizi Xing 1989 152 p Sponsored by Netherlands Technical Foundation
(ETN-90-96697) Avail: NTIS HC A08/MF A01

The realization of an electronic tilt sensor which is small in size, suitable for mass production, and capable of operating over a 360 degree measurement range with a moderate linearity, is investigated. A gravitation-orientation sensing unit, an angular position-sensitive detector, and an electronic signal-processing circuit using JFETs are described. Experimental results of a prototype electronic spirit level tilt sensor are presented. ESA

**N90-23711#** Ballistic Research Labs., Aberdeen Proving Ground, MD.
**AN EVALUATION OF IMBEDDED THERMOCOUPLES AS A SOLID-PROPELLANT COMBUSTION DIAGNOSTIC**
Martin S. Miller Mar. 1990 29 p Submitted for publication
(DA Proj. 1L1-61102-AH-43)
(AD-A219947; BRL-MR-3819) Avail: NTIS HC A03/MF A01 CSCL 21/2

There is a continuing need for temperature profiles through the combustion wave of solid propellants under steady-state conditions. This work aims at assessing the circumstances under which imbedded fine-gauge thermocouples can provide accurate results. Errors can arise from inadequate rates of thermal accommodation to the subject temperature field, from perturbation

of the field itself by mismatches in specific heat between thermocouple and propellant or by thermal conduction in the electrical leads from the junction, or from catalysis of local reactions at the surface temperatures because of energy loss by thermal radiation. A systematic approach is adopted wherein each of these sources of error is explored by methodical variation of controlling factors. The study is not yet complete, but preliminary results are presented for two gun propellants at three pressures using 50 micron Pt/Pt10 percent Rh thermocouples in three lead-angle configurations. GRA

**N90-23712*** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**FATIGUE TESTING APPARATUS Patent**
Robert J. Buzzard, inventor (to NASA) 17 Apr. 1990 8 p Filed 21 Aug. 1989 Supersedes N89-28806 (27 - 23, p 3296)
(NASA-Case-LEW-14124-1; US-Patent-4,916,954;
US-Patent-Appl-SN-396263; US-Patent-Class-73-799;
US-Patent-Class-73-845; Int-Patent-Class-G01N-3/32) Avail: US Patent and Trademark Office CSCL 14B

An apparatus is provided for obtaining a single crack in fatigue loading which emanates from a predetermined starting notch in a test specimen. This crack propagates in a direction in line with that of the applied Mode 2 load. The loading may be performed either monotonically or in a cyclic fatigue.
Official Gazette of the U.S. Patent and Trademark Office

**N90-23713*** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**REAL-TIME SIMULATION CLOCK Patent**
Donald R. Bennington, inventor (to NASA) and Daniel J. Crawford, inventor (to NASA) 17 Apr. 1990 12 p Filed 28 Sep. 1988 Continuation-in-part of abandoned US-Patent-Appl-SN-010949, filed 5 Feb. 1987
(NASA-Case-LAR-14056-1; US-Patent-4,918,652;
US-Patent-Appl-SN-251073; US-Patent-Appl-SN-010949;
US-Patent-Class-364-900; US-Patent-Class-364-933.8;
US-Patent-Class-364-934; US-Patent-Class-364-924.4;
US-Patent-Class-364-925.1; US-Patent-Class-364-578) Avail: US Patent and Trademark Office CSCL 14B

The invention is a clock for synchronizing operations within a high-speed, distributed data processing network. The clock is actually a distributed system comprising a central clock and multiple site clock interface units (SCIUs) which are connected by means of a fiber optic star network and which operate under control of separate clock software. The presently preferred embodiment is a part of the flight simulation system now in current use at the NASA Langley Research Center.
Official Gazette of the U.S. Patent and Trademark Office

**N90-23714*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**MULTIWAVELENGTH PYROMETRY TO CORRECT FOR REFLECTED RADIATION**
Daniel L. P. Ng Jun. 1990 13 p
(NASA-TM-102578; E-5409; NAS 1.15:102578) Avail: NTIS HC A03/MF A01 CSCL 14B

Computer curve fitting is used in multiwavelength pyrometry to measure the temperature of a surface in the presence of reflected radiation by decomposing its radiation spectrum. Computer-simulated spectra (at a surface temperature of 1000 K; in the wavelength region 0.3 to 20 microns; with a reflected radiation-source temperature of 700 to 2500 K; and reflector emissivity from 0.1 to 0.9) were generated and decomposed. This method of pyrometry determined the surface temperatures under these conditions to within 5 percent. The practicability of the method was further demonstrated by the successful analysis of a related problem--decomposition of the real spectrum of an infrared source containing two emitters to determine their temperatures. Author

**N90-23715#** Technische Univ., Delft (Netherlands).
**INTEGRATED SILICON FLOW SENSORS Ph.D. Thesis**
Bastiaan Willem vanOudheusden 1989 198 p Sponsored by Netherlands Technology Foundation
(ETN-90-96906) Avail: NTIS HC A09/MF A02

Research towards the realization and experimental testing of a direction-sensitive flow sensor made of a silicon-integrated sensor IC is presented. The operation of the sensor relies on a thermal principle, and comprises the measurement of temperature differences in a sensor surface which are caused by the nonuniform cooling of the heated surface. An application of the two dimensional flow sensors is discussed. A wind meter prototype was realized and tested in a wind tunnel. Major part of the research is related to sensors made from single, wafer-thick ICs. Results on a floating-membrane sensor, where silicon micromachining was used to form a thermal isolation structure within the chip, in order to enhance the sensitivity and response speed, are discussed.
ESA

# 36 LASERS AND MASERS

Includes parametric amplifiers.
For related information see also *76 Solid-State Physics*.

**N90-23716*#** Hampton Univ., VA. Dept. of Physics.
**MODELING OF THERMAL LENSING IN SIDE AND END-PUMPED FINITE SOLID-STATE LASER RODS M.S. Thesis**
Vincent G. Brackett Washington Jun. 1990 102 p
(Grant NAG1-666)
(NASA-CR-4300; NAS 1.26:4300) Avail: NTIS HC A06/MF A01 CSCL 20E

An analytical expression for approximating the time-dependent thermal focal length in finite solid state laser rods was derived. The analysis is based on the temperature variation of the material refractive index caused by optical pumping of these rods. Several quantities were found to be relevant to this analysis. These quantities were the specific thermal profiles of the rods, type of optical pumping employed, type of cooling scheme employed (side and end-cooling parameters), and the specific material characteristics of the rods. The Thermal Lensing Model was formulated using the geometric ray tracing approach. The focal lengths are then approximated, by calculating the phase shift in the index of refraction, as the different rays of an incident plane wave are tracked through a lens-like crystal medium. The approach also applies in the case of Gaussian or parabolic pump beams. It is shown that the prediction of thermal focal length is in good quantitative agreement with experimentally obtained data. Author

**N90-23717#** Lawrence Livermore National Lab., CA.
**PRECISION LASER CUTTING**
D. D. Kautz, C. D. Anglin, and T. J. Ramos 19 Jan. 1990 11 p Presented at the 3rd Biannual Conference on the Laser vs the Electron Beam in Welding, Cutting and Surface Treatment, Reno, NV, 1-5 Nov. 1989
(Contract W-7405-eng-48)
(DE90-009949; UCRL-99432; CONF-891164-1) Avail: NTIS HC A03/MF A01

Many materials that are otherwise difficult to fabricate can be cut precisely with lasers. This presentation discusses the advantages and limitations of laser cutting for refractory metals, ceramics, and composites. Cutting in these materials was performed with a 400-W, pulsed Nd:YAG laser. Important cutting parameters such as beam power, pulse waveforms, cutting gases, travel speed, and laser coupling are outlined. The effects of process parameters on cut quality are evaluated. Three variables are used to determine the cut quality: kerf width, slag adherence, and metallurgical characteristics of recast layers and heat-affected zones around the cuts. Results indicate that ductile materials with good coupling characteristics (such as stainless steel alloys and tantalum) cut well. Materials lacking one or both of these properties (such as tungsten and ceramics) are difficult to cut without proper part design, stress relief, or coupling aids. DOE

**N90-23718#** Illinois Univ., Urbana-Champaign. Dept. of Chemistry.
**ULTRAFAST LASER INVESTIGATION OF A SOLID-STATE EXPLOSION Final Report, 1 Sep. 1986 - 31 Dec. 1989**
Dana D. Dlott 29 Jan. 1990 6 p
(Contract DAAL03-86-K-0135)
(AD-A218530; ARO-23910.16-CH) Avail: NTIS HC A02/MF A01 CSCL 09/3

The response of solids composed of large molecules, to the rapid deposition of a large amount of energy was studied experimentally and theoretically. Laser equipment capable of inducing a solid state explosion, and studying, via ultrafast microscopy, and a variety of nonlinear optical techniques, was constructed, and used to investigate the behavior of a variety of solid materials on times ranging from 2 picoseconds (trillionths of a second) to seconds. The theory of statistical mechanics, and the methods of supercomputer simulations was used to analyze the results of the experiments, and to make predictions about planned experiments where laser driven shock waves are used to induce chemical reactions in energetic solids. GRA

**N90-23719#** Harry Diamond Labs., Adelphi, MD.
**EXPERIMENTAL DEMONSTRATION OF AN ELECTROMAGNETICALLY PUMPED FREE-ELECTRON LASER WITH CYCLOTRON HARMONIC IDLERS Summary Report, Jan. 1987 - Jun. 1988**
R. A. Kehs, Yuval Carmel, William Destler, and Victor L. Granatstein (Maryland Univ., College Park.) Feb. 1990 76 p
(AD-A218830; HDL-TR-2172) Avail: NTIS HC A05/MF A01 CSCL 09/3

A new type of electromagnetically pumped, three-wave free-electron laser (FEL) was observed in which cyclotron harmonic waves act as idlers. In this experiment, a powerful electromagnetic pump wave replaced the usual magnetostatic wiggler. The pump wave was generated by a backward wave oscillator (8.4 GHz, 50 MW peak power) driven by an intense relativistic electron beam (625 kV, 2 kA, 100 ns). A grating spectrometer was used to scan the microwave frequency spectrum from 50 to 130 GHz, and powerful high-frequency radiation was observed in the form of an array of regularly spaced peaks. The positions of the peaks were observed to vary with the magnitude of the axial guide magnetic field in a manner which agrees with the dispersion relationship omega(sub s) = omega(sub w) = (k sub w) (v sub g) + (k sub s) (v parallel) + l Omega(sub 0) due to a three-wave FEL interaction in which the cyclotron beam waves act as idler where omega(sub s), k(sub s) and omega(sub w), k(sub w) are the frequency and wave number of scattered and pump waves, omega(sub 0) is the relativistic electron cyclotron frequency, l is the harmonic number, and v parallel is the axial beam velocity. Harmonic numbers l = 1 and 5 to 14 are identified while sweeping through the frequency ranges from 7 to 18 GHz and 50 to 130 GHz. The results exhibit excellent agreement with a simple theoretical model of the three-wave interaction. GRA

**N90-23720#** Oklahoma State Univ., Stillwater. Dept. of Chemistry.
**NONLINEAR OPTICAL RESPONSES AND LASER DAMAGE THRESHOLDS OF FILMS OF A POLARIZED STILBENE SIDE CHAIN LIQUID CRYSTAL POLYMER AND A PHTHALOCYANINE Technical Report, 1 Apr. 1987 - 30 Sep. 1989**
Roger J. Reeves, Richard C. Powell, Marietta Bautista, Mingyand Zhao, and Weiming Zhu 15 Mar. 1990 26 p
(Contract N00014-87-K-0290)
(AD-A219462; TR-3) Avail: NTIS HC A03/MF A01 CSCL 07/6

Thin films of a side chain liquid crystal polymer (P-10) with a 4-dimethylaminostibene-4'carboxylic ester mesogen were measured to have degenerate four wave mixing efficiencies at 532 nm 18 times that of carbon disulfide and 0.55 times that of a film of 1.5 weight percent 4-dimethylamino-4'-nitrostilbene (DANS) in poly(methyl methacrylate) PMMA and second harmonic generation efficiency at 1064 nm 0.17 times that of a film of DANS in PMMA. A film of 2.0 weight percent of octakis (2-ethylhexylocy) phthalocyanato copper(II) in polystyrene was measured to have degenerate four wave mixing efficiency at 532 nm 19 times that of carbon disulfide. Single shot and cumulative laser induced damage thresholds were measured for all three materials at both wavelengths. GRA

**N90-23721#** Aerospace Corp., El Segundo, CA. Chemistry and Physics Lab.
**ATOMIC VELOCITY DISTRIBUTIONS OUT OF HYDROGEN MASER DISSOCIATORS**
B. Jaduszliwer and Y. C. Chan 15 Feb. 1990 33 p
(Contract F04701-88-C-0089)
(AD-A219500; TR-0090(5945-05)-1; SSD-TR-90-02) Avail: NTIS HC A03/MF A01 CSCL 09/3

Velocity distributions are determined for atoms effusing out of radio frequency discharge hydrogen dissociators, of the type used in hydrogen masers. This work was motivated by long-term reliability issues related to the possible use of masers as frequency standards on satellites. A primary issue is the maser's hydrogen budget, because many of the common failure modes of a maser involve either the hydrogen source or sink. Because the focusing properties of the state-selecting magnets are velocity dependent, the overall hydrogen budget will depend not only on the dissociation efficiency but also on the velocity distribution of the hydrogen atoms leaving the dissociation. Many times, that distribution has been tacitly assumed to be Maxwellian at wall temperature, but that assumption is not necessarily valid. The measurements show the distributions to be much narrower than Maxwellian and to broaden as the hydrogen pressure in the dissociator increases. Operating the dissociator to yield a relatively narrow velocity distribution and using a state-selecting magnet well matched to that distribution may significantly improve the efficiency of hydrogen use by the maser. GRA

**N90-23722#** School of Aerospace Medicine, Brooks AFB, TX. Human Systems Div.
**LASER EYE PROTECTION Interim Report, Jul. 1989 - Jan. 1990**
Ralph G. Allen, Jack A. Labo, and Michael W. Mayo Jan. 1990 14 p Submitted for publication
(AF Proj. 7757)
(AD-A219659; USAFSAM-PROC-89-27) Avail: NTIS HC A03/MF A01 CSCL 09/2

Laser applications have proliferated in recent years and, as to be expected, their presence is no longer confined to the laboratory or places where access to their radiation can be easily controlled. One obvious application where this is so is in military operations where various devices such as laser range finders, target designators, and secure communications equipment elevate the risk of exposure, specifically eye exposure, to unacceptable levels. Although the need for eye protection in the laboratory and other controlled areas has been appreciated since the invention of the laser, the use of lasers in circumstances where safety or the risk of temporary loss of vision, which can not always be ensured by administrative procedures, has made adequate eye protection essential. It is the critical nature of many military operations that has driven the search for eye protection against both nuclear and laser radiation. At the same time, the requirement to maintain useful vision during irradiation as well as advances in laser technology have complicated the problem enormously. Pertinent aspects of the problem, such as laser characteristics—pulse width, repetition rate, laser wavelength tunability or agility, as well as effects on vision for various exposures have been estimated, as have the characteristics required of eye protective devices. Various classes of devices are discussed, and advantages and disadvantages noted. GRA

**N90-23723#** Harvard Univ., Cambridge, MA. Div. of Applied Sciences.
**PICOSECOND LASER PULSE INTERACTIONS WITH METALLIC AND SEMICONDUCTING SURFACES Final Report, 1 Sep. 1985 - 31 Dec. 1987**

Eric Mazur and Frans Spaepen 31 Jan. 1990 78 p
(Contract N00014-85-K-0684)
(AD-A219680) Avail: NTIS HC A05/MF A01 CSCL 20/12

Pump-probe, ellipsometric, and streak camera measurements of the reflectivity following picosecond pulse irradiation of semiconductor, graphite, layered compound, and metal surface are reported. Overheating of crystal and liquid are analyzed. Crystallization of metals is shown to be collision-limited. Kinetic preference for formation of isotropic, small unit cell crystals is established. GRA

**N90-23724#** Maxwell Labs., Inc., San Diego, CA. Dept. of Laser.
**LONG PULSE NARROWBAND XeCl LASER STUDIES Final Report**
Michael C. Cates 15 Mar. 1990 141 p
(Contract N00014-85-C-0741)
(AD-A219774; MLR-3529) Avail: NTIS HC A07/MF A01 CSCL 09/3

Long pulse narrowband e-beam pumped excimer lasers are of interest for applications that require large amounts of energy to be delivered to a target. The e-beam pumping allows scaling to large energies. Increasing the laser pulse length while keeping the energy constant results in a lower laser flux, which eases design constraints on the laser optics for large systems. Atmospheric transmission can be improved by remaining under the simulated Raman scattering threshold, and laser target coupling improved by virtue of a lower plasma temperature. Narrow bandwidths are required to increase the efficiency of nonlinear processes, such as stimulated Raman and Brillouin scattering, which are used for beam combining, frequency shifting, and beam quality cleanup. With these advantages in mind, a program to develop, optimize, and study a long pulse narrowband XeCl laser was undertaken. The MLI Maximizer Laser, which had been previously modified to provide a long pulse e-beam, was used for the experiments. The narrowbanding was accomplished using intracavity etalons, and provided a 5 msec, 300 MHz XeCl laser pulse. This is the longest pulse width obtained with an e-beam pumped excimer laser. GRA

**N90-23725#** Naval Research Lab., Washington, DC. Beam Physics Branch.
**THE EFFECTS OF WIGGLER ERRORS ON FREE ELECTRON LASER PERFORMANCE Interim Report**
E. Esarey, W. Marable (Maryland Univ., College Park.), and C. M. Tang 2 Apr. 1990 25 p Sponsored in part by National Inst. of Standards and Technology and DOE
(Contract N00014-87-F-0066)
(AD-A220421; NRL-MR-6597; PR-9M0214) Avail: NTIS HC A03/MF A01 CSCL 09/3

The effects of random wiggler magnetic field errors on free electron lasers is analyzed analytically and computationally. Wiggler field errors perturb the electron beam as it propagates and lead to a random walk of the beam centroid delta x as well as cause deviations in the parallel beam energy delta gamma parallel and in the relative phase of the electrons in the ponderomotive wave delta psi. The phase deviation delta psi is identified as the single most important parameter characterizing the detrimental effects of wiggler errors. In order to avoid significant reduction in gain it is necessary for the phase deviation to be small compared to pi. It is shown that transverse focusing of the electron beam is not effective in reducing the phase deviation (i.e., transverse focusing reduces the average phase deviation by 1/2). Furthermore, it is shown that the results of beam steering at the wiggler entrance reduces the average phase deviation at the end of the wiggler by 1/3. The detrimental effects of wiggler errors may be reduced by arranging the magnet poles in an optimal ordering such that the magnitude of the phase deviation is minimized. GRA

**N90-23726#** Societe Bertin et Cie, Les Milles (France).
**SILEX BEACON EQUIPMENT**
Pierre-Jean Crepin, Pierrick Leblay, Regine Haller, Isabelle Tremillon, and Jean-Pierre Sonon 1990 7 p Presented at OE/LASE 1990 Symposium on Optics, Electro-Optics, and Laser Applications in Science and Engineering, Los Angeles, CA, 14-19 Jan. 1990 Prepared in cooperation with ETCA
(Contract SE-642-01-T)
(ETN-90-96613) Avail: NTIS HC A02/MF A01

The design of this equipment based on the use of nineteen 500 mW laser diodes is presented. The Beacon is a powerful and collimated optical source based upon semi-conductor lasers. This equipment is implemented in the SILEX GEO2 terminal and its function is to provide a continuous wave light beam towards the LEO or GEO1 satellites during the acquisition phases. The design was experimentally validated with a functional breadbord, and test results demonstrated the feasibility of every performance required by the SILEX system. ESA

**N90-23727#** Ortel Corp., Alhambra, CA.
**VERTICAL EMITTING, RING GEOMETRY, ULTRA-LOW THRESHOLD, AND ULTRA-HIGH SPEED QUANTUM WELL LASERS FOR OPTICAL INTERCONNECT Report, Nov. 1989 - Feb. 1990**
Michael Mittelstein and Nadav Bar-Chaim Feb. 1990 10 p
(Contract N00014-88-C-0483; DARPA Order 6325)
(AD-A219946) Avail: NTIS HC A02/MF A01 CSCL 09/3

The main emphasis during this quarter was placed on: (1) evaluation of structures suitable for vertically emitting ring lasers; (2) fabrication of gratings on non-planar surfaces; and (3) presentation at a DoD Fiber Optics Conference. GRA

**N90-23728#** Avco-Everett Research Lab., MA.
**ELECTRON BEAM PUMPED XeF(C YIELDS A) LASER SCALING Final Report, 1 Jul. 1988 - 31 Dec. 1989**
Leonard N. Litzenberger and Alexander E. Mandl Feb. 1990 65 p
(Contract N00014-88-C-0418)
(AD-A220022) Avail: NTIS HC A04/MF A01 CSCL 09/3

Efficient operation of the electron beam pumped XeF (C to A) laser under conditions which are scalable to large devices has been demonstrated. A five-component laser gas mixture at a pressure of 2.6 ATM was pumped at a rate of 290 kW/cu cm with a 600-ns electron beam pulse. The laser gas mixture and output coupler reflectivity were carefully optimized under free-running conditions, and radiation was then injected into the stable cavity from an external flashlamp-pumped dye laser to reduce the flux buildup time to saturation levels. An intrinsic efficiency of 1.8 percent and a specific output energy of 3 J/l were demonstrated, and a total energy of 4 J was extracted from the e-beam excited medium. GRA

**N90-23729#** Harry Diamond Labs., Adelphi, MD.
**SPECTRAL PROPERTIES OF A 1.3-MICROMETERS InGaAsP DIODE LASER UNDER MODULATION Final Report, Sep. 1987 - Feb. 1988**
Fred Semendy and Emanuel Katzen Aug. 1989 19 p Sponsored by Army Lab. Command, Adelphi, MD
(AD-A220066; HDL-TR-2165) Avail: NTIS HC A03/MF A01 CSCL 09/1

Direct modulation of a buried heterostructure (BH) InGaAsP laser diode was performed up to 18 GHz, and FM properties were observed. The number of lasing modes increased with increasing modulation depth. For a given RF power, the FM index went from 0.7 to 0 as the modulation frequency was increased. These measurements indicate that the nonlinear gain effects mainly influence the modulation characteristics of this laser, and wider bandwidths and modulation indexes can be achieved in this type of multimode device. GRA

**N90-23730#** Massachusetts Inst. of Tech., Cambridge. Plasma Fusion Center.
**MICROWIGGLERS FOR SUBMILLIMETER WAVELENGTH FREE-ELECTRON LASERS Annual Report, 1 Feb. 1989 - 31 Jan. 1990**
George Bekefi 28 Mar. 1990 21 p

(Contract N00014-89-J-1654; ONR Proj. 4127794-02)
(AD-A220185) Avail: NTIS HC A03/MF A01 CSCL 09/3

We have designed and tested an electromagnet planar microwiggler for use in free-electron lasers (FELs), constructed of current conductors wound on ferromagnetic cores. A prototype with a period of 1 cm and gap of 0.5 cm produced a peak field on axis in excess of 4.6 kG, with a linear B/H characteristic to about 3.2 kG. The field of each half-period of the wiggler is independently tuneable by adjusting the current delivered to each, thus allowing for precision tuning and/or wiggler tapering. We employ general scaling laws to predict performance of a geometrically similar design with a period of 5 mm. GRA

# 37 MECHANICAL ENGINEERING

Includes auxiliary systems (nonpower); machine elements and processes; and mechanical equipment.

**N90-23731*#** United Technologies Research Center, East Hartford, CT.
**THE EFFECTS OF REYNOLDS NUMBER, ROTOR INCIDENCE ANGLE, AND SURFACE ROUGHNESS ON THE HEAT TRANSFER DISTRIBUTION IN A LARGE-SCALE TURBINE ROTOR PASSAGE Final Report**
Michael F. Blair and Olof L. Anderson Nov. 1989 144 p
Original contains color illustrations
(Contract NAS8-37351)
(NASA-CR-183891; NAS 1.26:183891; UTRC-R89-957852-24)
Avail: NTIS HC A07/MF A01; 4 functional color pages CSCL 13I

A combined experimental and computational program was conducted to examine the heat transfer distribution in a turbine rotor passage geometrically similiar to the Space Shuttle Main Engine (SSME) High Pressure Fuel Turbopump (HPFTP). Heat transfer was measured and computed for both the full-span suction and pressure surfaces of the rotor airfoil as well as for the hub endwall surface. The primary objective of the program was to provide a benchmark-quality data base for the assessment of rotor passage heat transfer computational procedures. The experimental portion of the study was conducted in a large-scale, ambient temperature, rotating turbine model. Heat transfer data were obtained using thermocouple and liquid-crystal techniques to measure temperature distributions on the thin, electrically-heated skin of the rotor passage model. Test data were obtained for various combinations of Reynolds number, rotor incidence angle and model surface roughness. The data are reported in the form of contour maps of Stanton number. These heat distribution maps revealed numerous local effects produced by the three-dimensional flows within the rotor passage. Of particular importance were regions of local enhancement produced on the airfoil suction surface by the main-passage and tip-leakage vortices and on the hub endwall by the leading-edge horseshoe vortex system. The computational portion consisted of the application of a well-posed parabolized Navier-Stokes analysis to the calculation of the three-dimensional viscous flow through ducts simulating the a gas turbine passage. These cases include a 90 deg turning duct, a gas turbine cascade simulating a stator passage, and a gas turbine rotor passage including Coriolis forces. The calculated results were evaluated using experimental data of the three-dimensional velocity fields, wall static pressures, and wall heat transfer on the suction surface of the turbine airfoil and on the end wall. Particular attention was paid to an accurate modeling of the passage vortex and to the development of the wall boundary layers including crossflow.
Author

**N90-23732*#** Ohio State Univ., Columbus. Dept. of Mechanical Engineering.
**NON-LINEAR DYNAMIC ANALYSIS OF GEARED SYSTEMS, PART 2 Final Report**
Rajendra Singh, Donald R. Houser, and Ahmet Kahraman Feb. 1990 263 p
(Grant NAG3-773)
(NASA-CR-180495; NAS 1.26:180495) Avail: NTIS HC A12/MF A02 CSCL 13I

A good understanding of the steady state dynamic behavior of a geared system is required in order to design reliable and quiet transmissions. This study focuses on a system containing a spur gear pair with backlash and periodically time-varying mesh stiffness, and rolling element bearings with clearance type non-linearities. A dynamic finite element model of the linear time-invariant (LTI) system is developed. Effects of several system parameters, such as torsional and transverse flexibilities of the shafts and prime mover/load inertias, on free and force vibration characteristics are investigated. Several reduced order LTI models are developed and validated by comparing their eigen solution with the finite element model results. Several key system parameters such as mean load and damping ratio are identified and their effects on the non-linear frequency response are evaluated quantitatively. Other fundamental issues such as the dynamic coupling between non-linear modes, dynamic interactions between component non-linearities and time-varying mesh stiffness, and the existence of subharmonic and chaotic solutions including routes to chaos have also been examined in depth. Author

**N90-23733** Southampton Univ. (England).
**DIESEL ENGINE CONDITION MONITORING: LASER-BASED DIAGNOSTIC TECHNIQUES Ph.D. Thesis**
Paul Graham Eastwood 1989 352 p
Avail: Univ. Microfilms Order No. BRDX87351

The principles of laser-based non-contact vibration measurement are discussed and its potential application to diesel engine condition monitoring studied. In the first instance, two laser transducers are described which measure normal-to-surface and torsional vibration velocities and are respectively named the Laser Vibrometer and the Laser Torsional Vibrometer. In particular, the development of the latter is considered in some detail and it is shown how the instrument's optical geometry provides the capability to obtain accurate measurements of torsional vibration from a rotating component of arbitrary cross-section, with the additional advantages of insensitivity to solid-body motion of the target surface or operator. The production of a prototype on-site instrument is described, which can accommodate target rotational speeds from 150 to 6000 rpm and torsional vibration frequencies from dc to 1 KHz. Three applications of these laser vibration transducers to diesel engine condition monitoring are then examined. The Laser Vibrometer is used to measure the vibration response of an operating fuel injector and a technique is described which analyses this response to provide information regarding the condition of both the injector unit, itself, and the fuel injection pump/delivery pipeline. A prototype monitoring device which employs this technique is described and results presented to demonstrate its ability in detecting changes in the nozzle opening pressure setting of an injector installed on a running engine. The Laser Torsional Vibrometer is used to measure the torsional vibration response at the free end of the engine crankshaft and it is shown that, through suitable analysis and interpretation of torsional data obtained at this measurement position, it is theoretically possible to assess the balance of power across the engine cylinders. Dissert. Abstr.

**N90-23734*#** Georgia Inst. of Tech., Atlanta. School of Mechanical Engineering.
**TWO WHEELED LUNAR DUMPTRUCK**
Michael R. Brus, Ray Haleblain, Tomas L. Hernandez, Paul E. Jensen, Ronald L. Kraynick, Stan J. Langley, and Alan G. Shuman Dec. 1988 111 p
(Grant NGT-21-002-800)
(NASA-CR-182840; NAS 1.26:182840; ME-4182) Avail: NTIS HC A06/MF A01 CSCL 13I

The design of a two wheel bulk material transport vehicle is described in detail. The design consists of a modified cylindrical bowl, two independently controlled direct drive motors, and two deformable wheels. The bowl has a carrying capacity of 2.8 m (100 ft) and is constructed of aluminum. The low speed, high HP

motors are directly connected to the wheels, thus yielding only two moving parts. The wheels, specifically designed for lunar applications, utilize the chevron tread pattern for optimum traction. The vehicle is maneuvered by varying the relative angular velocities of the wheels. The bulk material being transported is unloaded by utilizing the motors to oscillate the bowl back and forth to a height at which dumping is achieved. The analytical models were tested using a scaled prototype of the lunar transport vehicle. The experimental data correlated well with theoretical predictions. Thus, the design established provides a feasible alternative for the handling of bulk material on the moon. Author

**N90-23735*#** Georgia Inst. of Tech., Atlanta. School of Mechanical Engineering.
**LUNAR ROBOTIC MAINTENANCE MODULE**
Michael L. Ayres Dec. 1988 35 p
(Grant NGT-21-002-800)
(NASA-CR-183071; NAS 1.26:183071; ME-4182) Avail: NTIS
HC A03/MF A01 CSCL 13I

A design for a robotic maintenance module that will assist a mobile 100-meter lunar drill is introduced. The design considers the following areas of interest: the atmospheric conditions, actuator systems, power supply, material selection, weight, cooling system and operation. Author

**N90-23736*#** Georgia Inst. of Tech., Atlanta. School of Mechanical Engineering.
**LUNAR DRILL AND TEST APPARATUS**
David W. Norrington, Didier C. Ardoin, Stephen G. Alexander, Philip N. Rowland, Frank N. Vastakis, and Steven L. Linsey Nov. 1988 96 p
(Grant NGT-21-002-800)
(NASA-CR-183052; NAS 1.26:183052; ME-4182) Avail: NTIS
HC A05/MF A01 CSCL 13I

The design of an experimental lunar drill and a facility to test the drill under simulated lunar conditions is described. The drill utilizes a polycrystalline diamond compact drag bit and an auger to mechanically remove cuttings from the hole. The drill will be tested in a vacuum chamber and powered through a vacuum seal by a drive mechanism located above the chamber. A general description of the design is provided followed by a detailed description and analysis of each component. Recommendations for the further development of the design are included. Author

**N90-23737*#** Georgia Inst. of Tech., Atlanta. School of Mechanical Engineering.
**LUNAR RATED FASTENERS**
Lindsey Gupton, Steve Hyde, Dan McKillip, Bryan Player, and Greg Smith 1988 111 p
(Grant NGT-21-002-800)
(NASA-CR-182856; NAS 1.26:182856; ME-4182) Avail: NTIS
HC A06/MF A01 CSCL 13I

A catalog of fasteners is presented for a variety of applications to be used in a lunar environment. The fastening applications targeted include: covers, panels, hatches, bearings, wheels, gears, pulleys, anchors for the lunar surface and structural fasteners (general duty preloadable). The robotic installation and removal of each fastener is presented along with a discussion of failure modes. Structural performance data is tabulated for various configurations. Potential materials for the space environment are presented along with recommendations of appropriate solid film lubricants. Three original fastener designs were found suitable for the lunar environment. A structural analysis is presented for each original design. Author

**N90-23738*#** Georgia Inst. of Tech., Atlanta. School of Mechanical Engineering.
**LUNAR DRILL FOOTPLATE AND CASING**
Erik C. Maassen, Thomas H. Hendrix, Eddie W. Morrison, Rodrick B. Phillips, Vu Quang Le, and Bruce A. Works Mar. 1989 86 p
(Grant NGT-21-002-800)
(NASA-CR-183153; NAS 1.26:183153; ME-4182) Avail: NTIS
HC A05/MF A01 CSCL 13I

To prevent hole collapse during lunar drilling operations, a casing has been devised of a graphite reinforced polyimide composite which will be able to withstand the lunar environment. Additionally, this casing will be inserted into the ground in segments two meters long which will penetrate the regolith simultaneously with the auger. The vertical action of the mobile platform will provide a downward force to the casing string through a special adaptor, giving the casing the needed impetus to sink the anticipated depth of ten meters. Casing segments will be connected with a simple snap arrangement. Excess casing will be cut off by a cylindrical cutting tool which will also transport the excess casing away from the hole. A footplate will be incorporated to grasp the auger rod string during rod segment additions or removals. The footplate grasping mechanism will consist of a set of vice-like arms, one end of each bearing threaded to a common power screw. The power screw will be threaded such that one end's thread pitch opposes that of the other end. The weight of the auger and rod string will be transmitted through the arms to the power screw and absorbed by a set of three ball bearing assemblies. The power screw will be driven by a one-half horsepower brushless motor actuated by radio control. The footplate will rest on four short legs and be anchored with pins that are an integral part of each leg. Author

**N90-23739*#** Georgia Inst. of Tech., Atlanta. School of Mechanical Engineering.
**ROD GRIPPER, CHANGER, AND STORAGE SYSTEM Final Report**
Mark Benson, Todd Demi, Robert McNeill, Keith Waldo, Alex Afghan, and Jim Oliver 8 Mar. 1989 116 p
(Grant NGT-21-002-800)
(NASA-CR-183154; NAS 1.26:183154; ME-4182) Avail: NTIS
HC A06/MF A01 CSCL 13I

A rod changer and storage design is presented for the lunar deep drill apparatus to be used in conjunction with the Skitter walking platform. The design must take into account all of the lunar environment and working conditions. Some of these are: (1) the moon has one sixth the gravity of earth; (2) temperature gradients can range from about -170 to 265 C; (3) because of the high transportation costs, the design must be as light as possible; and (4) the process must be remotely operated (from earth or satellite) and must be automated. Because of Skitter's multiple degree of freedom movement, the design will utilize Skitter's movement to locate an implement and transport it from the rack to the drill string. The implement will be gripped by a thumb and two finger device, identified through an electronic sensing device on the thumb, and transported from the rack to the footplate and back from the footplate to the rack. The major designs discussed in this report have been broken down into three major areas: (1) gripper design (linear transport mechanism); (2) indexing system; and (3) rack design. Author

**N90-23740*#** Georgia Inst. of Tech., Atlanta. School of Mechanical Engineering.
**CORE SAMPLE EXTRACTOR**
James Akins, Billy Cobb, Steve Hart, Jeff Leaptrotte, James Milhollin, and Mark Pernik 1989 81 p
(Grant NGT-21-002-800)
(NASA-CR-182864; NAS 1.26:182864; ME-4182) Avail: NTIS
HC A05/MF A01 CSCL 13I

The problem of retrieving and storing core samples from a hole drilled on the lunar surface is addressed. The total depth of the hole in question is 50 meters with a maximum diameter of 100 millimeters. The core sample itself has a diameter of 60 millimeters and will be two meters in length. It is therefore necessary to retrieve and store 25 core samples per hole. The design utilizes a control system that will stop the mechanism at a certain depth, a cam-linkage system that will fracture the core, and a storage system that will save and catalogue the cores to be extracted. The Rod Changer and Storage Design Group will provide the necessary tooling to get into the hole as well as to the core. The mechanical design for the cam-linkage system as well as the conceptual design of the storage device are described. Author

**N90-23741*#** Georgia Inst. of Tech., Atlanta. School of Mechanical Engineering.
**LUNAR STONE SAW**
Tom Clark, Todd Croker, Ken Hines, Mike Knight, and Todd Walton Dec. 1988 78 p
(Grant NGT-21-002-800)
(NASA-CR-182438; NAS 1.26:182438; ME-4182) Avail: NTIS HC A05/MF A01 CSCL 13I

This project addresses the problem of cutting lunar stones into blocks to be used to construct shelters to protect personnel and equipment from harmful solar radiation. This plant will manufacture 6 in x 1 ft x 2 ft blocks and will be located near the south pole to allow it to be in the shade at all times. This design uses a computer controlled robot, a boulder handler that uses hydraulics for movement, a computer system that used 3-D vision to determine the size of boulders, a polycrystalline diamond tipped saw blade that utilizes radiation for cooling, and a solar tower to collect solar energy. Only two electric motors are used in this plant because of the heavy weight of electric motors and the problem of cooling them. These two motors will be cooled by thermoelectric cooling. All other motors and actuators are to be hydraulic. The architectural design for the building as well as the conceptual design of the machines for cutting the blocks are described. Author

**N90-23742*** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**CABLE SUSPENDED WINDMILL Patent**
Moses G. Farmer, inventor (to NASA) 16 Jan. 1990 8 p Filed 15 Sep. 1988
(NASA-Case-LAR-13434-1; US-Patent-4,894,554; US-Patent-Appl-SN-246594; US-Patent-Class-290-55; US-Patent-Class-290-44; US-Patent-Class-416-9; Int-Patent-Class-F03D-9/00) Avail: US Patent and Trademark Office CSCL 10A

A windmill is disclosed which includes an airframe having an upwind end and a downwind end. The first rotor is rotatably connected to the airframe, and a generator is supported by the airframe and driven by the rotor. The airframe is supported vertically in an elevated disposition by poles which extend vertically upwardly from the ground and support cables which extend between the vertical poles. Suspension cables suspend the airframe from the support cable.
Official Gazette of the U.S. Patent and Trademark Office

**N90-23743#** Ballistic Research Labs., Aberdeen Proving Ground, MD.
**NUMERICAL SIMULATION OF SEMI-INFINITE TARGET PENETRATION BY CONTINUOUS AND SEGMENTED RODS Technical Report, 1988 - 1989**
J. A. Zukas Feb. 1990 30 p
(AD-A219437; BRL-TR-3081) Avail: NTIS HC A03/MF A01 CSCL 19/4

Results are presented for a numerical study of continuous and segmented rod impacts into semi-infinite steel targets at velocities of 1.5 to 4 km/s. Variations in segment spacing and number of segments comprising a segmented rod were considered in addition to striking velocity variations. It is found that below 2 km/s, there is no advantage (in terms of penetration) in using segmented rods over continuous rods. However, for striking velocities exceeding 2 km/s, segmented rods show improved penetration with proper adjustment of segment number and spacing. GRA

**N90-23744#** Pennsylvania State Univ., University Park. Applied Research Lab.
**PREDICTION OF GEAR TOOTH SEPARATION IN SINGLE-STAGE GEAR SYSTEMS, USING NUMERICAL TECHNIQUES**
Warren G. Greczyn and Martin J. Pechersky Apr. 1990 156 p
(Contract N00024-85-C-6041)
(AD-A220442; ARL/PSU/TR-90-005) Avail: NTIS HC A08/MF A01 CSCL 13/9

The following report describes a comprehensive numerical procedure for predicting tooth separation in a single-stage gear system, and provides information on its programming and use. This programmed procedure, named Gearsep, allows any segment of a spur gear train to be analyzed for the critical operating conditions under which tooth separation can occur. Gear tooth separation, as evaluated in this report, occurs when the varying compliances (or, conversely, the stiffnesses) of the meshing teeth cause the contacting tooth pair to react against the system's shafts to such an extent that tooth surfaces loose contact with one another. When the teeth regain contact, they do so with an impact, causing high tooth stresses and unwanted noise. The numerical procedure takes readily available gear analytical compliance model for a pair of mating teeth moving through different contact positions. This model is passed to a numerical integration scheme which determines relative gear motion, and thus predicts separation. The particular tooth compliance model choosen is based on straightforward strength of materials concepts. This report presents a sample gear train investigation and confirms the accuracy and stability of the numerical integration algorithm by comparing it with an analytical solution of a simplified gear system. GRA

**N90-23745#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**STATISTICAL TECHNIQUES FOR DESIGNING A DECOUPLED CONTROLLER TO BE ROBUST TO MODEL AND SENSOR NOISE M.S. Thesis**
Jeb Ewell Brewer Mar. 1990 151 p
(AD-A220476; AFIT/GA/ENY/90M-1) Avail: NTIS HC A08/MF A01 CSCL 12/3

This thesis developed and tested statistical design methods for configuring a robust decoupled controller on a lightly damped structure. The test model used was a lumped mass finite element representation of the Charles Stark draper Laboratory Model I (CSDL-I). The decoupled control methods consisted of a system of three individual subcontrcilers designed on the basis of a subset of plant dynamics with control authority enacted through the total system of structural actuators. Transforms were applied to the subcontrollers to insure that dynamic coupling, called observation spillover and control spillover, didn't destabilize the global system. The decoupled controller system was designed based on only the first eight of the twelve natural frequencies (modes) for the CSDL-I. The remaining four high frequency modes were modeled as residuals. This investigation used signal-to-noise ratios, orthogonal numerical experiments, and linear regression to efficiently probe the design space and to produce a robust control system. The measure of system performance was the structural alignment of a particular node referred to a line-of-sight (LOS). GRA

**N90-23746#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**FRACTIONAL STATE FEEDBACK CONTROL OF UNDAMPED AND VISCOELASTICALLY-DAMPED STRUCTURES M.S. Thesis**
David L. Yang Mar. 1990 106 p
(AD-A220477; AFIT/GA/ENY/90M-3) Avail: NTIS HC A06/MF A01 CSCL 22/1

The purpose of this thesis is to demonstrate the analysis leading to the development of the fractional order state feedback control theory for structural control of both undamped and viscoelastically-damped structures. It is shown herein that there exists a relation between the traditional state vector that includes structural displacements and velocities, and the fractional state vector which includes fractional derivatives of structural responses. This relation permits the modification of linear quadratic regulator theory to include the application of fractional order states in the feedback control. The application of this theory leads to an alternative form of an observer. GRA

**N90-23747#** Helsinki Univ. of Technology, Espoo (Finland). Internal Combustion Engine Lab.
**DEVELOPMENT OF A SPARK ASSISTED DIRECT INJECTION MULTIFUEL DIESEL ENGINE ESPECIALLY FOR ALCOHOL FUELS Ph.D. Thesis**

E. U. Ubong 1989 85 p Sponsored by Nigerian Federal Ministry of Education and Finnish Ministry of Trade and Industry (Acta-Polytec-Scand-Me-94; ISBN-951-666-288-9; ISSN-0001-687X; ETN-90-96566) Avail: NTIS HC A05/MF A01

A multifuel, multispark assisted diesel engine (SADE) is developed. The combustion studies of the engine performance on ethanol fuel is presented. An investigation into the effect of multispark, variable spark duration on combustion variables and the engine performance is presented. This leads to the appropriate information concerning novel approaches to attaining a higher brake thermal efficiency and reducing exhaust emissions in future engines. This concept improves the operational limit, especially the lean limits of combustion of the developed engine. The results obtained showed that a SADE with a multispark discharge (MSD) ignitor and a variable spark duration has superior combustion characteristics to an equivalent conventional diesel engine in brake power, brake thermal efficiency, cylinder pressure, brake mean effective pressure, rate of cylinder pressure rise and cleaner exhaust. The engine developed a high brake thermal efficiency which makes its economy superior to the conventional SADE alcohol fueled and moderately turbocharged diesel in this category. The engine does not smoke and the overall performance makes it available for all spark compression ignition engine fuels including less volatile and self ignition resistant types of fuels. ESA

**N90-23748#** Centre de Recherches Scientifiques et Techniques de l'Industrie des Fabrications Metalliques, Brussels (Belgium). Section Construction Metallique.

**HIGH RESISTANCE BOLTS: TEST TRIALS FOR PLATED BOLTS [BOULONS A HAUTE RESISTANCE: ESSAIS DE FONCTIONNEMENT DE BOULONS REVETUS]**

E. Piraprez Oct. 1989 33 p In FRENCH Sponsored by Institut pour l'Encouragement de la Recherche Scientifique dans l'Industrie et l'Agriculture

(CRIF-MT-178; ETN-90-96576) Avail: NTIS HC A03/MF A01

The effect of different coating materials on the ability to tighten high resistance bolts is studied. Different lubricants are used in these tightening tests. The results show very different behavior depending on the type of anti-corrosion coating used and the type of lubricant. The quality of the coatings is not tested. Galvanized coatings, zinc and cadminum coatings and other mechanical galvanizing treatments are tested. Resin-based corrosion protection treatments are tested. These resins also serve as lubricants. ESA

**N90-23749#** Naval Postgraduate School, Monterey, CA. Dept. of Electrical and Computer Engineering.

**ADAPTIVE CONTROL METHODS FOR MECHANICAL MANIPULATORS: A COMPARATIVE STUDY M.S. Thesis**

Hamadi Jamali Dec. 1989 163 p

(AD-A219965) Avail: NTIS HC A08/MF A01 CSCL 09/1

A new adaptive control law for mechanical manipulators that maintains uniformly good performance over a wide range of motions and payloads is developed. This control strategy combines properties from both the Model Reference Adaptive Control and the Self Tuning Regulator Theory and serves to extend the Adaptive Model Following Control approach into using a nonlinear reference model. The design procedure is simple resulting in an overall system which is globally stable and offers itself to microcomputer implementation. The effectiveness of the approach is demonstrated on several computer simulations which compares its performances against some of the commonly known adaptive control techniques. Also presented is a comparison of the computation complexity of different methods used in deriving the dynamic equations of motion of a mechanical manipulator as well as a survey of various robot control methodologies available in the literature today. GRA

**N90-23750#** Crystallume, Menlo Park, CA.

**CVD DIAMOND FILMS FOR TRIBOLOGICAL APPLICATIONS Final Report**

Linda S. Plano, Ian Hayward, and John Wegand (Geo-Centers, Inc., Fort Washington, MD.) 31 Mar. 1990 46 p (Contract N00014-89-C-0151; NR Proj. S40-5018)

(AD-A220265) Avail: NTIS HC A03/MF A01 CSCL 11/3

Friction and wear behavior of several types of diamond film has been studied using sapphire on diamond film and diamond on diamond film tests. The coefficient of friction of the films was found to be a strong function of film morphology for sapphire on diamond film tests, and of diamond bonding content for diamond on diamond film tests. Smooth films were found to have coefficients of friction approaching the lower value for natural diamond (0.05), regardless of bonding composition. Films were deposited in three groups. Film morphology and graphite content were varied in the first group. In the second group, increased growth rates of highly diamond-bonded material were sought. Smooth, very fine grained material of varied bonding content was produced in the third. Attempts at surface planarization through etching and regrowth were not successful. All films were found to have excellent adhesion to both silicon and silicon carbide substrates. This study indicates that CVD diamond films have excellent potential for use as solid-film bearings, and that this potential merits further work. GRA

**N90-23751*** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

**HIGH TEMPERATURE FLEXIBLE SEAL Patent**

Bruce M. Steinetz, inventor (to NASA) and Paul J. Sirocky, inventor (to NASA) 17 Apr. 1990 9 p Filed 30 Dec. 1988 Supersedes N89-28830 (27 - 23, p 3301)

(NASA-Case-LEW-14695-1; US-Patent-4,917,302; US-Patent-Appl-SN-292146; US-Patent-Class-239-265.11; US-Patent-Class-277-34; US-Patent-Class-277-158; Int-Patent-Class-B64D-33/04; Int-Patent-Class-F16J-15/46) Avail: US Patent and Trademark Office CSCL 11A

This device is concerned with sealing the sliding interfaces between structural panels that are roughly perpendicular to each other or whose edges are butted against one another. The gap which the seal element must seal is not uniform along the seal length requiring significant seal flexibility. The seal is mounted in a rectangular groove in a moveable structural panel. The seal comprises a plurality of rectangular shaped wafers stacked next to one another and preloaded in the axial direction to minimize leakage between wafers. The wafers are laterally preloaded to maintain sealing contact along the wafer faces which engage the adjacent wall of a sidewall using one of several approaches, such as the pressurized linear bellows. The seal accommodates distortions in the adjacent panel by relative sliding between adjacent wafers. Leakage between wafers is further minimized with good wafer surface finishes. Leakage between the seal nose and the adjacent structural panel is minimized when sealing against a distorted sidewall with relatively thin wafers and suitable seal preload apparatus. Leakage behind the seal is minimized with good groove tolerances and good sealing contact between the preload system and the back of the peripheral edge of the wafers. Official Gazette of the U.S. Patent and Trademark Office

# 38 QUALITY ASSURANCE AND RELIABILITY

Includes product sampling procedures and techniques; and quality control.

**N90-23752#** Pratt and Whitney Aircraft, West Palm Beach, FL. Materials Engineering and Technology Labs.

**FAILURE ANALYSIS HANDBOOK Final Report, 1 Sep. 1986 - 29 Apr. 1989**

C. R. Walker and K. K. Starr 18 Aug. 1989 759 p (Contract F33615-86-C-5007; AF Proj. 2418)

(AD-A219747; PW/ED/FR-20820; WRDC-TR-89-4060) Avail: NTIS HC A99/MF A04 CSCL 11/6

Aircraft service failures of any type, from a simple rivet failure to complete engine failure, have the potential to result in loss of the aircraft and personnel. Accurate determination of the cause of the failure may yield information that will prevent similar future

failures from occurring. It is helpful for the investigator to have a data base of known failure modes to draw from in forming conclusions. The objective of this program was to update and augment the two primary Air Force failure analysis handbooks, Electron Fractography Handbook and SEM/TEM Fractography Handbook, published in 1965 and 1975, respectively, with a new Failure Analysis Handbook. The new handbook includes fractography of alloys and conditions not previously covered in other handbooks. The handbook also is a guide for procedures and lists other sources of information. GRA

**N90-23753#** Aerospatiale Aquitaine, Saint-Medard en Jalles (France). Strategic and Space Systems Div.
**AN EXPERT SYSTEM FOR THE STUDY OF HIGH DUTY BONDED JOINTS IN AEROSPACE STRUCTURES**
J. P. Maigret and M. Laborie 20 Sep. 1989 10 p
(Rept-892-430-110; ETN-90-96641) Avail: NTIS HC A02/MF A01

The industrial and technical context of the strategic and space division, in which bonded structures are studied, is shown. The numerous dependances between the variables which act on quality of bonded joints are reviewed. The means presently developed in order to increase the reliability of structures and reduce the cost and delays of studies are presented. Examples to situate the technical level and field of utilization of these means are given. ESA

**N90-23754*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**THEORY AND EXPERIMENTAL TECHNIQUE FOR NONDESTRUCTIVE EVALUATION OF CERAMIC COMPOSITES**
Edward R. Generazio 1990 18 p Presented at the March Meeting of the American Society for Nondestructive Testing, Columbus, OH, 15 Mar. 1990
(NASA-TM-102561; E-5381; NAS 1.15:102561) Avail: NTIS HC A03/MF A01 CSCL 14E

The important ultrasonic scattering mechanisms for SiC and Si3N4 ceramic composites were identified by examining the interaction of ultrasound with individual fibers, pores, and grains. The dominant scattering mechanisms were identified as asymmetric refractive scattering due to porosity gradients in the matrix material, and symmetric diffractive scattering at the fiber-to-matrix interface and at individual pores. The effect of the ultrasonic reflection coefficient and surface roughness in the ultrasonic evaluation was highlighted. A new nonintrusive ultrasonic evaluation technique, angular power spectrum scanning (APSS), was presented that is sensitive to microstructural variations in composites. Preliminary results indicate that APSS will yield information on the composite microstructure that is not available by any other nondestructive technique. Author

**N90-23755#** Sanders Associates, Inc., Nashua, NH. Software Systems Engineering.
**FASTER: THE FAULT TOLERANT ARCHITECTURE SIMULATION TOOL FOR EVALUATING RELIABILITY, INTRODUCTION AND APPLICATIONS Final Technical Report, Oct. 1985 - Jan. 1989**
P. Zemany, D. Goller, and Terry Ginn Feb. 1990 123 p
(Contract F03602-85-C-0317; AF Proj. B413)
(AD-A219941; RADC-TR-89-363) Avail: NTIS HC A06/MF A01 CSCL 12/5

FASTER (Fault Tolerant Architecture Simulation Tool for Evaluating Reliability) is a Monte Carlo Simulator which is used to evaluate reliability figures of merit for complex reconfigurable fault tolerant systems. The process used to specify a complex system is simplified with the use of constraint directed editors. The editors ease the interaction process which guides the user through system configuration and mission scenario input. Complete and well defined system specifications are produced as a result of the interactive constraint directed editors. The FASTER program was designed to be flexible, and thus allows for the modeling and evaluation of a wide range of fault tolerant system types and considerations. For example, FASTER can account for the effects of both active and standby redundancy, imperfect switching and diagnostics, multiphase mission scenarios, and various maintenance and repair philosophies such as scheduled preventive, immediate or deferred maintenance. Figures of merit calculable by the FASTER program include, but are not limited to, reliability, availability, mean-time-between-critical-failure (MTBCF), MTBF, and mean-time-to-repair (MTTR). GRA

**N90-23756*** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**METHOD OF RADIOGRAPHIC INSPECTION OF WOODEN MEMBERS Patent**
Maggie L. Berry, inventor (to NASA) and Robert F. Berry, Jr., inventor (to NASA) 6 Feb. 1990 6 p Filed 25 Nov. 1987 Supersedes N88-23983 (26 - 17, p 2346)
(NASA-Case-LAR-13724-1; US-Patent-4,899,356; US-Patent-Appl-SN-125678; US-Patent-Class-378-58; US-Patent-Class-378-51; Int-Patent-Class-G01B-15/06) Avail: US Patent and Trademark Office CSCL 14D

The invention is a method to be used for radiographic inspection of a wooden specimen for internal defects which includes the steps of introducing a radiopaque penetrant into any internal defects in the specimen through surface openings; passing a beam of radiation through a portion of the specimen to be inspected; and making a radiographic film image of the radiation passing through the specimen, with the radiopaque penetrant in the specimen absorbing the radiation passing through it, thereby enhancing the resulting image of the internal defects in the specimen. Official Gazette of the U.S. Patent and Trademark Office

# 39 STRUCTURAL MECHANICS

Includes structural element design and weight analysis; fatigue; and thermal stress.

For applications see *05 Aircraft Design, Testing and Performance* and *18 Spacecraft Design, Testing and Performance.*

**N90-23757*#** Toledo Univ., OH. Dept. of Mechanical Engineering.
**APPLICATION OF FINITE-ELEMENT-BASED SOLUTION TECHNOLOGIES FOR VISCOPLASTIC STRUCTURAL ANALYSES Final Report**
V. K. Arya Mar. 1990 14 p Original contains color illustrations
(Contract NCC3-120)
(NASA-CR-185196; E-5187; NAS 1.26:185196) Avail: NTIS HC A03/MF A01; 1 functional color page CSCL 20K

Finite-element solution technology developed for use in conjunction with advanced viscoplastic models is described. The development of such solution technology is necessary for performing stress/life analyses of engineering structural problems where the complex geometries and loadings make the conventional analytical solutions difficult. The versatility of the solution technology is demonstrated by applying it to viscoplastic models possessing different mathematical structures and encompassing isotropic and anisotropic material. The computational results qualitatively replicate deformation behavior observed in experiments on prototypical structural components. Author

**N90-23758** Council for National Academic Awards (England).
**THEORETICAL ANALYSIS AND PRESSURE DISTRIBUTION OF THIN-WALLED METAL INVERBUCKLE ENERGY ABSORBING TUBES Ph.D. Thesis**
Efford Clive Chirwa 1988 237 p
Avail: Univ. Microfilms Order No. BRDX86763

The energy absorbing capacity of thin-walled metal inverbucktubes loaded in axial compression is investigated. The inversion-buckling (curling-buckling) behavior achieved in both quasi-static and dynamic loading conditions is also presented. In addition, for the first time, the experimental results of the pressure of normal stress distribution between the inside surface of the

inverbucktube and die fillet radius interface are stipulated. These were very successful using the pressure transducer method. Furthermore, a mathematical model has been developed based on theory of plasticity and making use of energy method. This predicts the amount of energy absorbed in the assumed separate collapse processes. Results yielded from the theory showed good agreement with the experimental results which had geometry factor within feasibility boundaries of inverbuckling collapse (6.5 less than or equal to bar -D/2t(sub A) less than or equal to 22.5). The successful prediction of energy absorbed, inverbuckling load and pressure distribution not only proves the validity of the model, but also confirms the quality of the modeling approach proposed. Using this mathematical model, inverbucktubes could be designed, developed, and applied. Author

**N90-23759** Rensselaer Polytechnic Inst., Troy, NY.
**AN ORTHOTROPIC THEORY OF VISCOPLASTICITY BASED ON OVERSTRESS FOR THERMOMECHANICAL DEFORMATION AND ITS APPLICATION TO LAMINATED METAL MATRIX COMPOSITES Ph.D. Thesis**
Kyoung-Don Lee 1989 155 p
Avail: Univ. Microfilms Order No. DA9011308

An infinitesimal, orthotropic theory of viscoplasticity based on overstress for both isothermal and thermal loading cases is presented. The theory is based on existing isotropic formulations of the viscoplasticity theory based on overstress. All material constants and functions can be functions of temperature. Since invariance requirements constrain the orthotropic growth laws for the state variables, a comparatively simple theory is obtained. The theory models creep, relaxation, rate sensitivity, hysteresis, work, hardening, and tension/compression symmetry and can be reduced to the transversely isotropic, cubic symmetric, and isotropic cases. The theory can be specialized for the cases of inelastic incompressibility, invariance of inelastic properties under superimposed pressure, and tension/compression symmetry. The uniaxial behaviors of the thermal theory are investigated for three different materials. The elastic, inelastic, and cyclic behaviors as well as a temperature rate effect of each material are demonstrated and compared for various thermochemical loading conditions. The orthotropic, thermal viscoplasticity theory based on overseas (OTVBO) is specialized for plane stress in a simple laminate theory. The geometric assumptions of the classical laminate theory are maintained but that the orthotropic linear elasticity law is replaced by OTVBO. The laminate theory is intended for thermal analysis of metal matrix composites operating at high temperature under simultaneous mechanical and thermal loadings. The rate-dependent laminate behavior is described by a set of couples, first order, nonlinear differential equations which must by numerically integrated for a given mechanical and thermal history to yield the laminate and ply stresses or the laminate total strain as a function of time. Two metal matrix composites are constructed theoretically for numerical analysis. Dissert. Abstr.

**N90-23760#** Technische Univ., Delft (Netherlands). Faculty of Aerospace Engineering.
**FRACTOGRAPHIC OBSERVATIONS ON FATIGUE CRACK GROWTH IN 2024-T3 SHEET MATERIAL UNDER FLIGHT-SIMULATION LOADING**
O. Partl (Czech Technical Univ., Prague.) and J. Schijve Apr. 1989 43 p
(LR-592; ETN-90-96350) Avail: NTIS HC A03/MF A01

Fatigue crack propagation is studied under random flight simulation loading and two types of programmed flight sequences. Tests are carried out on 2024-T3 Alclad specimens. Fractographic observations are made to determine the severity of individual flight types. Seven different flight types from a total of ten can be distinguished on the fatigue failure surfaces. Their severity is determined on the basis of crack extension. ESA

**N90-23761#** Army Armament Research, Development and Engineering Center, Watervliet, NY.
**WIDE RANGE STRESS INTENSITY FACTOR AND CRACK-MOUTH-OPENING DISPLACEMENT EXPRESSIONS SUITABLE FOR SHORT CRACK FRACTURE TESTING WITH ARC BEND-CHORD SUPPORT SAMPLES Final Report**
J. A. Kapp Jan. 1990 20 p Submitted for publication
Sponsored by Army Armament Research, Development, and Engineering Center, Picatinny Arsenal, NJ
(AD-A218395; ARCCB-TR-90001) Avail: NTIS HC A03/MF A01 CSCL 20/11

The correct short crack limit solutions for both the stress intensity factor and the crack-mouth-opening displacement are derived for the arc bend-chord support specimen. The short crack limit, along with the deep crack limit, is used to develop wide range interpolating polynomials to estimate the stress intensity factor and crack-mount-opening displacement over a wide range of possible specimen configurations and crack lengths. The polynomials are developed such that the limit for short cracks is the most accurate. More accurate expressions can be found elsewhere for crack lengths and specimen geometries more commonly used in fracture toughness determination or fatigue crack propagation. GRA

**N90-23762#** Dayton Univ., OH.
**NONDESTRUCTIVE MEASUREMENT OF RESIDUAL STRESSES IN AIRCRAFT TRANSPARENCIES Final Interim Report, Dec. 1984 - Feb. 1987**
B. Basava Raju and Blaine S. West Nov. 1989 109 p
(Contract F33615-84-C-3404; AF Proj. 1926)
(AD-A218680; UDR-TR-88-65; WRDC-TR-89-3099) Avail: NTIS HC A06/MF A01 CSCL 01/3

This program was conducted to: (1) Design, fabricate, and set up a photoelastic test apparatus capable of measuring residual stresses in aircraft transparencies; (2) Evaluate the accuracy of the scattered-light photoelastic technique by conducting scattered-light photoelastic experiments on four-point bending polycarbonate specimens having known analytical solutions and other experimental solutions; (3) Establish a scattered-light photoelastic experimental procedure for monolithic polycarbonate F-16 transparencies by measuring residual stresses at a typical station on the transparency; (4) Evaluate the scattered-light photoelastic properties of acrylic plastic material; and (5) Determine the feasibility of using acoustic wave ultrasonic techniques to determine residual stresses in transparencies. GRA

**N90-23763#** Texas Univ., Austin. Applied Research Labs.
**SELF-CALIBRATING APPARATUS TO FIND DYNAMIC COMPRESSIBILITY OF ORGANIC SOLIDS**
David E. Edmonds 29 Nov. 1989 94 p
(AD-A219780; ARL-TR-89-53) Avail: NTIS HC A05/MF A01 CSCL 11/9

A self-calibrating apparatus was developed to measure the adiabatic dynamic compressibility of organic solids. The test chamber is a small cavity where bulk cyclic compression is accomplished and monitored with piezoelectric transducers (simple disks). The chamber is different from other chambers of similar design in that it can be re-calibrated at each data point without changing static pressure, opening the chamber, or using a calibration sample. Self-calibration is accomplished using a chamber cavity which is divided into a main chamber and two side-chambers. One side-chamber contains the sample suspended in pressure fluid; the other contains only pressure fluid. The main chamber contains transducers and a remotely operated door. The door may close off either side-chamber or be left open, allowing the three measurement conditions required to calibrate the chamber. Much of the measurement process is monitored or controlled by a Hewlett-Packard HP-85 desktop computer through dc control voltages or an HPIB bus. Data were taken in isothermal runs at pressures stepped down from 8000 or 10,000 psi in 2000, 1000, or 500 psi increments. Poly(vinyl acetate) (PVAc), and polytetrafluoroethylene (Teflon) were tested and the results

compared to data obtained by other researchers using other means. This comparison showed that the apparatus yields reliable, useful data. GRA

**N90-23764#** Washington Univ., Seattle. Dept. of Mechanical Engineering.
**J-INTEGRAL AND HRR FIELD OF A STABLY GROWING CRACK, AN EXPERIMENTAL ANALYSIS**
Mahyar S. Dadkhah, Bruce S.-J. Kang (West Virginia Univ., Morgantown.), and Albert S. Kobayashi Apr. 1990 13 p
(Contract N00014-89-J-1276)
(AD-A220418; UWA/DME/TR-90/65) Avail: NTIS HC A02/MF A01 CSCL 11/6

The displacement fields surrounding stably growing cracks in 7075-T6, 2024-0, 2024-T3, 5052-H32 and 2091 aluminum alloy, standard and cruciform, single-edge notched (SEN) specimens were determined by Moire interferometry. An approximate and exact J-integral values were determined and found to be within 5 percent of each other and were both path independent. The associated HRR crack tip displacements in all specimens were in agreement with the measured displacements vertical to the crack but consistently differed in magnitude and order of singularity with the measured displacements parallel to the crack. One of the most popular ductile fracture criterion of the past two decades is the J-integral concept (1) for which enormous developmental efforts have been expended in recent years. The J-integral is heralded by many as a stable crack growth and ductile fracture criteria since in its linearly elastic limit, it reduces to the elastic strain energy release rate. GRA

**N90-23765#** Missouri Univ., Rolla. Dept. of Mechanical and Aerospace Engineering.
**EFFECT OF CONSTITUTIVE MODELING ON THE DYNAMIC DEVELOPMENT OF SHEAR BANDS IN VISCOPLASTIC MATERIALS**
R. C. Batra and C. H. Kim 1990 12 p
(Contract DAAL03-88-K-0184)
(AD-A220443; ARO-25396.14-MA) Avail: NTIS HC A03/MF A01 CSCL 20/11

The viscoplastic response of a HY-100 steel by a Power law, and flow rules proposed by Litonski, Bodner and Partom, and Johnson and Cook were modeled. Each of these flow rules is first calibrated by using the torsional test data at a strain-rate of 3,300 sec(-1). These material models are then used to study the thermomechanical deformations of a block made of the HY-100 steel and undergoing simple shearing deformations at a nominal strain-rate of 5000 sec(-1). A material defect is simulated by assuming a non-uniform initial temperature distribution within the block. Whereas all of the flow rules used predict a rapid drop of the shear stress as a shear band forms, only for the Litonski Law for nonpolar materials, does an unloading elastic wave amanate outwards from the shear bands. GRA

**N90-23766#** Defence Research Establishment Atlantic, Dartmouth (Nova Scotia).
**FINITE ELEMENT FORMULATIONS FOR COUPLED FLUID/STRUCTURE EIGENVALUE ANALYSIS**
Thomas A. Vernon Sep. 1989 61 p
(AD-A220793; DREA-TM-89/223) Avail: NTIS HC A04/MF A01 CSCL 20/1

This report summarizes recent work directed toward the development of an effective finite element-based eigensolution capability for coupled fluid/structure interaction problems in which fluid compressibility is included. Solution of these coupled problems is essential in the evaluation of structural acoustic transmission characteristics and enclosure acoustics. The methods are also of direct relevance to the acoustic radiation problem as well as other forms of time domain analysis. A comprehensive review is made of the four general methods most compatible with existing finite element analysis capability. Several example applications of the different methods are presented to highlight practical considerations. Of the formulations reviewed, a three-field system appears to have the most potential as a general purpose approach, although considerable effort is required in the development of a suitable eigensolver for the system of choice. The report also discusses a number of methods of incorporating concentrated damping in finite element models of acoustic domains. GRA

**N90-23767#** Army Armament Research, Development and Engineering Center, Watervliet, NY.
**BRITTLE TORSIONAL FATIGUE CRACK INITIATION IN AN OTHERWISE DUCTILE ENVIRONMENT Final Technical Report**
R. B. Fujczak and A. A. Kapusta Mar. 1990 22 p
(AD-A220858; ARCCB-TR-90008) Avail: NTIS HC A03/MF A01 CSCL 11/6

The results of a torsional fatigue test program on marage 250 steel indicate that the usual fatigue failure mechanism occurs as a flat ductile fracture along the cross section of the test specimens. However, a small number of specimens displayed a small penny-shaped crack on the outer surface at a 45-degree helix, typical of brittle torsional failure, before the final ductile failure. Scanning electron microscope examination showed that the brittle failure was caused by a brittle inclusion on the outside surface of the specimen. GRA

**N90-23768*#** National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
**STARS: AN INTEGRATED GENERAL-PURPOSE FINITE ELEMENT STRUCTURAL, AEROELASTIC, AND AEROSERVOELASTIC ANALYSIS COMPUTER PROGRAM**
K. K. Gupta Jun. 1990 167 p
(NASA-TM-101709; H-1582; NAS 1.15:101709) Avail: NTIS HC A08/MF A01 CSCL 20K

The details of an integrated general-purpose finite element structural analysis computer program which is also capable of solving complex multidisciplinary problems is presented. Thus, the SOLIDS module of the program possesses an extensive finite element library suitable for modeling most practical problems and is capable of solving statics, vibration, buckling, and dynamic response problems of complex structures, including spinning ones. The aerodynamic module, AERO, enables computation of unsteady aerodynamic forces for both subsonic and supersonic flow for subsequent flutter and divergence analysis of the structure. The associated aeroservoelastic analysis module, ASE, effects aero-structural-control stability analysis yielding frequency responses as well as damping characteristics of the structure. The program is written in standard FORTRAN to run on a wide variety of computers. Extensive graphics, preprocessing, and postprocessing routines are also available pertaining to a number of terminals. Author

**N90-23769*#** Toledo Univ., OH.
**FINITE ELEMENT ANALYSIS OF STRUCTURAL COMPONENTS USING VISCOPLASTIC MODELS WITH APPLICATION TO A COWL LIP PROBLEM Final Report**
V. K. Arya Jun. 1990 19 p Original contains color illustrations
(Contract NCC3-120)
(NASA-CR-185189; E-4920; NAS 1.26:185189) Avail: NTIS HC A03/MF A01; 4 functional color pages CSCL 20K

The viability of advanced viscoplastic models for nonlinear finite element analyses of structural components is investigated. Several uniaxial and a multiaxial problem are analyzed using the finite element implementation of Freed's viscoplastic model. Good agreement between the experimental and calculated uniaxial results validates the finite element implementation and gives confidence to apply it to more complex multiaxial problems. A comparison of results for a sample structural component (the cowl lip of a hypersonic engine inlet) with the earlier elastic, elastic-plastic, and elastic-plastic-creep analyses available in the literature shows that the elastic-viscoplastic analyses yield more reasonable stress and strain distributions. Finally, the versatility of the finite-element-based solution technology presented herein is demonstrated by applying it to another viscoplastic model. Author

**N90-23770*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**A VISCOPLASTIC MODEL WITH APPLICATION TO LIF-22 PERCENT CaF2 HYPEREUTECTIC SALT**
A. D. Freed and K. P. Walker (Engineering Science Software, Inc., Smithfield, RI.) 1990 13 p Proposed for presentation at the 3rd International Conference on Constitutive Laws for Engineering Materials: Theory and Applications and Workshop on Innovative Use of Materials in Industrial and Infrastructure Design and Manufacturing, Tucson, AZ,
(NASA-TM-103181; E-5559; NAS 1.15:103181) Avail: NTIS HC A03/MF A01 CSCL 20K

A viscoplastic model for class M (metal-like behavior) materials is presented. One novel feature is its use of internal variables to change the stress exponent of creep (where n is approximately = 5) to that of natural creep (where n = 3), in accordance with experimental observations. Another feature is the introduction of a coupling in the evolution equations of the kinematic and isotropic internal variables, making thermal recovery of the kinematic variable implicit. These features enable the viscoplastic model to reduce to that of steady-state creep in closed form. In addition, the hardening parameters associated with the two internal state variables (one scalar-valued, the other tensor-valued) are considered to be functions of state, instead of being taken as constant-valued. This feature enables each internal variable to represent a much wider spectrum of internal states for the material. The model is applied to a LiF-22 percent CaF2 hypereutectic salt, which is being considered as a thermal energy storage material for space-based solar dynamic power systems. Author

**N90-23771#** Wisconsin Univ., Madison. Center for Mathematical Sciences.
**ERROR CANCELLATION IN HPBL DERIVATION OF ELASTIC HOLE-PRESSURE ERROR Technical Summary Report**
M. Yao and D. S. Malkus Dec. 1989 23 p
(Grants AF-AFOSR-0141-85; NSF DMS-87-12058; NSF DMS-89-07264)
(AD-A219854; CMS-TSR-90-18) Avail: NTIS HC A03/MF A01 CSCL 20/11

Analytical studies of the hole-pressure error for non-Newtonian creeping flows over a transverse slot are pursued with particular interest in the theory of Higashitani, Pritchard, Baird and Lodge (HPBL). To correctly apply the HPBL theory a modified hole-pressure relation (MHPR) is employed. Some important mathematical properties of the MHPR are presented. By studying the MHPR in streamline coordinate formulation we find a fortuitous error cancellation phenomenon in the derivation of HPBL formula. For second-order fluid and Tanner's viscometric model (under certain assumptions) the error cancellation is proved to be exact. It is this error cancellation phenomenon that provides a complete theoretical explanation for the paradox between an apparently flawed derivation and the fortunate success of the HPBL prediction. GRA

**N90-23772#** Wisconsin Univ., Madison. Center for Mathematical Sciences.
**STRAIN SOFTENING IN VISCOELASTICITY OF THE RATE TYPE Summary Report**
Athanasios E. Tzavaras Mar. 1990 34 p
(Contract DAAL03-88-K-0185; NSF DMS-87-1632)
(AD-A219915; CMS-TSR-90-22) Avail: NTIS HC A03/MF A01 CSCL 20/11

A motivation for studying this problem stems from a program of understanding the phenomenon of shear band formation at high strain rates. Shear bands are narrow regions of intensely concentrated shearing deformation that are observed during the plastic deformation of many materials. The occurrence of shear bands is typically associated with strain softening type response, past a critical strain, of the measured average shear stress versus the measured average shear strain. Various mechanisms and associated continuum thermomechanics models, often depending of the particular context, have been proposed for the explanation of shear bands. A underlying common feature of several models is that they are regularizations of an ill-posed problem, or that the associated linearized problem exhibits growth of high frequency modes. GRA

**N90-23773*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**STRESS VERSUS TEMPERATURE DEPENDENT ACTIVATION ENERGIES IN CREEP**
A. D. Freed, S. V. Raj, and K. P. Walker (Engineering Science Software, Inc., Smithfield, RI.) 1990 12 p Proposed for presentation at the 3rd International Conference on Constitutive Laws for Engineering Materials: Theory and Applications and Workshop on Innovative Use of Materials in Industrial and Infrastructure Design and Manufacturing, Tucson, AZ, 7
(NASA-TM-103192; E-5580; NAS 1.15:103192) Avail: NTIS HC A03/MF A01 CSCL 20K

The activation energy for creep at low stresses and elevated temperatures is lattice diffusion, where the rate controlling mechanism for deformation is dislocation climb. At higher stresses and intermediate temperatures, the rate controlling mechanism changes from that of dislocation climb to one of obstacle-controlled dislocation glide. Along with this change, there occurs a change in the activation energy. It is shown that a temperature-dependent Gibbs free energy does a good job of correlating steady-state creep data, while a stress-dependent Gibbs free energy does a less desirable job of correlating the same data. Applications are made to copper and a LiF-22 mol. percent CaF2 hypereutectic salt. Author

# 42 GEOSCIENCES (GENERAL)

No abstracts in this category.

# 43 EARTH RESOURCES AND REMOTE SENSING

Includes remote sensing of earth resources by aircraft and spacecraft; photogrammetry; and aerial photography.

For instrumentation see *35 Instrumentation and Photography.*

**N90-23774#** Army Cold Regions Research and Engineering Lab., Hanover, NH. Geophysical Sciences Branch.
**A LABORATORY COMPARISON OF FIELD TECHNIQUES FOR MEASUREMENT OF THE LIQUID WATER FRACTION OF SNOW Special Report**
Harold S. Boyne and David J. Fisk Feb. 1990 13 p
(DA Proj. 4A7-62730-AT-42)
(AD-A219587; CRREL-SR-90-3) Avail: NTIS HC A02/MF A01 CSCL 08/12

The amount and distribution of liquid water in a snow cover is important for assessing its mechanical strength, meltwater generation and meltwater transmission. It also has a profound effect on the performance of active and passive remote sensing systems operating in the microwave and millimeter wave regions of the electromagnetic spectrum. New methods of measuring liquid water have been reported that show considerable promise. Tests of measurement equivalence are described, in which are compared the three absolute methods of freezing calorimetry, alcohol calorimetry and dilution. Also compared are a capacitance snow moisture meter and one of the absolute methods. All comparisons were made in a laboratory coldroom using homogeneous snow with a mass liquid water content that varied from 0 to 14 percent. The comparisons show that the methods are equivalent and that the experimental errors associated with the measurements are consistent with what is expected from an error analysis of each

method. However, the operational achievement of equivalence depends strongly on a variety of factors such as sample size, mixing of snow and working fluid, and operator skill. GRA

**N90-23775#** Army Cold Regions Research and Engineering Lab., Hanover, NH.
**ICE CONDITIONS ALONG THE ILLINOIS WATERWAY AS OBSERVED ON LANDSAT IMAGES, 1972 TO 1985**
Lawrence W. Gatto Dec. 1989 122 p
(AD-A219745; CRREL-89-20) Avail: NTIS HC A06/MF A01 CSCL 08/12

LANDSAT images were used to map ice distributions along the navigable portions of the Illinois Waterway from the Mississippi River to Lake Michigan, and air temperature and discharge data were used to characterize the conditions under which the observed ice formed and changed. The presence or absence of ice on adjacent water bodies, i.e., lakes, channels and sloughs, is also discussed but not mapped. Ice was observed on the waterway during 10 of the 13 winters from 1972 to 1985, with the most severe ice conditions in 1981 to 1982 when 79 percent of the waterway was ice covered, of which 68 percent was white ice on 4 February. The most extensive ice was observed during 1984 to 1985 when 83 percent of the waterway was ice covered, but only 38 percent was white ice. Ice was observed on the adjacent water bodies every winter for about 100 days from early to mid-December to mid-March. Ice conditions changed frequently on the navigation channel of the waterway and usually lasted an average of 63 days from middle to late December to middle to late February. Air temperature and discharge data and data from LANDSAT images, when used together, provide a reasonably reliable method to study river ice conditions and changes. GRA

**N90-23776#** Army Cold Regions Research and Engineering Lab., Hanover, NH.
**THE CHEMICAL AND STRUCTURAL PROPERTIES OF SEA ICE IN THE SOUTHERN BEAUFORT SEA**
Debra A. Meese Dec. 1989 143 p
(Contracts N00014-87-WM-24012; N6845268-MP-60003; DA Proj. 4A1-61102-AT-24)
(AD-A219746; CRREL-89-25) Avail: NTIS HC A07/MF A01 CSCL 08/12

A detailed chemical and structural profile of first-year and multiyear Arctic sea ice is presented. Ice cores were collected during April to May 1986 and 1987 near Prudhoe Bay, Alaska. Concentrations of Cl, Br, SO4, Na, Ca, K, Mg, PO4, SiO4, NO3, NO2 and NH4 were determined for samples chosen on the basis of structural ice type. Chemical and statistical analyses indicate that finer-grained structures incorporate more impurities and that major ion chemistry is controlled almost entirely by salinity. Mg is enriched in the ice indicating precipitation is occurring at temperatures higher than previously reported. K is depleted in the ice suggesting preferrential drainage. Ratios of the major ions are the same for first-year and multiyear ice and are similar to that of seawater indicating that as the ice ages no significant changes occur in ice chemistry. Nutrient concentrations in the ice are enriched with respect to the underlying water, indicating that biological activity occurs in the ice and processes other than the overall salinity effect and brine drainage are affecting nutrient concentrations within the ice. GRA

**N90-23777#** Technische Univ., Delft (Netherlands). Werkeenheid Fotogrammetrie en Remote Sensing.
**TOPOGRAPHIC MAPPING FROM SPOT SATELLITE IMAGERY Thesis**
Daan vanderHoeven Jun. 1989 138 p Sponsored by Beleidscommissie Remote Sensing, Delft, Netherlands
(ETN-90-96689) Avail: NTIS HC A07/MF A01

An overview of the SPOT satellite system and products is given. The goal of research was to realize an operational environment capable of stereo plotting from SPOT imagery and to investigate to what extent SPOT imagery can compete with aerial photography for topographic mapping purposes at scale 1:50,000. The absolute orientation precision of a SPOT stereo model and the information content and interpretability of such a model are studied. A SPOT stereo model is concluded to ensure sufficient precision for mapping at scale 1:50,000. Detailed conclusions and recommendations are summarized. ESA

**N90-23778#** Technische Univ., Delft (Netherlands). Werkeenheid Fotogrammetrie en Remote Sensing.
**THE USE OF ADDITIONAL GLOBAL POSITIONING SYSTEM (GPS) OBSERVATIONS IN LARGE SCALE PHOTOGRAMMETRY Thesis [HET GEBRUIK VAN ADDITIONELE GPS WAARNEMINGEN IN DE GROOTSCHALIGE FOTOGRAMMETRIE]**
Ewout Korpershoek Jul. 1989 96 p In DUTCH
(ETN-90-96693) Avail: NTIS HC A05/MF A01

Global Positioning System (GPS) measurements made during a test flight were analyzed. A simulation study was performed for a synthetic photogrammetric block in order to investigate the possible reduction of the amount of control points when using GPS observables, the influence systematic effects in the inner orientation elements of the camera and their compensation by simultaneous self-calibration, and the estimation of a constant offset within the block adjustment program. A large reduction of control points is possible, while the precision of the terrain points is still within the reach made by the Survey department. The effects of systematic errors can effectively be compensated without serious loss of terrain points precision. The problem of the determination of offset and drift is not yet solved. ESA

**N90-23779#** Beleidscommissie Remote Sensing, Delft (Netherlands).
**THE VIERS-1 PROJECT. THE DELFT WIND/WAVE EXPERIMENT: EXPERIMENT AND FIRST RESULTS, PART 1 Progress Report**
D. vanHalsema, C. Calkoen, B. Jaehne, W. A. Oost, P. Snoeij, and S. Waas (Heidelberg Univ., Germany, F.R. ) Nov. 1989 129 p Sponsored in part by the State Baden-Wuerttemberg
(Contract ST2J-0451-C(GDF))
(BCRS-89-24-Pt-1; ETN-90-96764) Avail: NTIS HC A07/MF A01

The Delft wind/wave experiment of the VIERS-1 (preparation interpretation of ERS-1 data) program, conducted in Nov. 1987 and Mar. 1988, is described. The aim of the project is the preparation for interpreting ERS-1 data and to obtain operational information on geophysical parameters. The equipment and measurement procedures used and the experimental program are examined. The processing of the data and a discussion of the first results are carried out. The future processing of the data and concluding remarks are included. ESA

**N90-23780*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**SENSOR PERFORMANCE ANALYSIS**
H. E. Montgomery, H. Ostrow, and G. M. Ressler (Ressler Associates, Inc., Laurel, MD.) Washington Jul. 1990 90 p
(NASA-RP-1241; Rept-89B00057; NAS 1.61:1241) Avail: NTIS HC A05/MF A01 CSCL 14B

The theory is described and the equations required to design are developed and the performance of electro-optical sensor systems that operate from the visible through the thermal infrared spectral regions are analyzed. Methods to compute essential optical and detector parameters, signal-to-noise ratio, MTF, and figures of merit such as NE delta rho and NE delta T are developed. A set of atmospheric tables are provided to determine scene radiance in the visible spectral region. The Planck function is used to determine radiance in the infrared. The equations developed were incorporated in a spreadsheet so that a wide variety of sensor studies can be rapidly and efficiently conducted. Author

**N90-23781#** Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.).
**EARTH OBSERVATION FROM THE INTERSTELLAR SPACE [ERDBEOBACHTUNG AUS DEM WELTRAUM]**

25 Oct. 1989 51 p In GERMAN
(Rept-44/89; ETN-90-96449) Avail: NTIS HC A04/MF A01

A review of some results of satellite observations is presented. The main topics include: improvement of the weather predictions (Meteosat), climatology research (atmosphere, oceans, polar areas), environment research and control (ATMOS satellite, ecology), geophysics, geology, cartography, geodesy. Several projects such as Airborne Version Conical Scanning Radiometer, Precise Range and Range Rate Equipment, Scanning Radiometer for Radiation Budget Measurements, are briefly described. ESA

**N90-23782#** Technische Univ., Delft (Netherlands). Faculty of Geodesy.
**GUIDED BOUNDARY DETECTION IN A DIGITAL IMAGE USING DYNAMIC PROGRAMMING Thesis [GERICHTE GRENSDETECTIE IN EEN DIGITAAL BEELD MBV. DYNAMISCH PROGRAMMEREN]**
P. J. M. Meijers Aug. 1989 85 p In DUTCH; ENGLISH summary
(ETN-90-96688) Avail: NTIS HC A05/MF A01

The precision of a positional procedure for the detection of boundaries and lines in a digital image is studied. On the one hand the automatic procedure performs a guided bounded detection using the dynamic programming theory. Guided signifies that the available (old) information of a geographic information system is used to perform the dynamic programming approach only on those parts of the image where a boundary can be expected. Such an area is called a Region Of Interest (ROI). On the other hand the procedure can perform a statistical check in the ROI for determining the presence of a line or boundary. The procedure is simple and effective, and can perform a very precise automatic image segmentation . The only problem are boundaries and line that lie close to each other. ESA

**N90-23783#** Technische Univ., Delft (Netherlands). Faculty of Geodesy.
**THE ACCURACY OF THE MONITORING OF PIONEER VEGETATION IN THE OOSTVAARDERSPLASSEN, NETHERLANDS Thesis [MONITORING VAN PIONIERVEGETATIES IN DE OOSTVAARDERSPLASSEN EEN BESCHOUWING VAN DE NAUWKEURIGHEID]**
Pieter W. Bresters Jun. 1989 95 p In DUTCH
(ETN-90-96692) Avail: NTIS HC A05/MF A01

A method to determine changes in pioneer vegetations in the natural area Oostvaardersplassen (Netherlands) is developed. The starting point was a series of false color IR aerial pictures taken over three years. The changes in the vegetation were determined on a vector basis by interpreting and digitizing the pictures, and on a raster basis by scanning the pictures. Discrimination between positional and thematic changes was made. The precision of the observation of both changes is discussed. ESA

**N90-23784#** Beleidscommissie Remote Sensing, Delft (Netherlands).
**OPERATIONAL DIGITAL LAND USE MAP 1:50,000; INVESTIGATION OF A MULTIPLE AUTOMATIC CLASSIFICATION BASED ON SPOT AND LANDSAT THEMATIC MAPPER SATELLITE PICTURES Final Report [OPERATIONELE DIGITALE LANDGEBRUIKSKAART 1:50,000; EEN ONDERZOEK NAAR EEN MEERVOUDIGE AUTOMATISCHE CLASSIFICATIE OP BASIS VAN SPOT- EN LANDSAT THEMATIC MAPPER SATELLIETBEELDEN]**
J. L. vanGenderen, U. Uiterwijk, and D. J. Harms, ed. (Eurosense B.V., Breda, Netherlands ) Jul. 1989 39 p In DUTCH; ENGLISH summary
(BCRS-89-10; ETN-90-96759) Avail: NTIS HC A03/MF A01

A completely digitally derived thematic map was produced by a combination of satellite image classification of land use and topographic information. The map was made from a combination of spectral, textural and visual classifications of part of an integrated SPOT multispectral and panchromatic image with an overlay made of topographic information, digitally extracted from the existing topographic map. Three thematic maps were derived from the main map as examples of applications concerning urban change, land use conflicts, and growth in quarry development. ESA

**N90-23785#** Beleidscommissie Remote Sensing, Delft (Netherlands).
**VISION OF THE REMOTE SENSING MANAGEMENT COMMISSION ON THE ESA LONG TERM EARTH OBSERVATION PROGRAM [VISIE VAN DE BCRS OP HET ESA LANGE TERMIJN PROGRAMMA VOOR AARDOBSERVATIE]**
Jul. 1989 25 p In DUTCH
(BCRS-89-11; ETN-90-96760) Avail: NTIS HC A03/MF A01

The vision of the Dutch Remote Sensing Management Commission on the ESA-LTP on Earth observation is formulated with a view to the forthcoming decision making in the Netherlands concerning a possible participation in the ERS-2 program. An historical survey of the preparation and decision making concerning ESA proposals is given. The aims, strategy and the content of the ESA-LTP on Earth observation are described, and the importance for the Netherlands is outlined. The conclusions and recommendations of the Commission are given. ESA

**N90-23786#** Beleidscommissie Remote Sensing, Delft (Netherlands).
**ATMOSPHERIC CORRECTION OF SATELLITE PICTURES IN THE FRAMEWORK OF THE PROJECT FRIESE FRONTEN Final Report [ATMOSFERISCHE CORRECTIE VAN SATELLIETBEELDEN IN HET KADER VAN HET FRIESE FRONTEN PROJECT]**
A. H. J. M. Pellemans Jul. 1989 19 p In DUTCH Original contains colors illustrations
(BCRS-89-12; ETN-90-96761) Avail: NTIS HC A03/MF A01

The method for the atmospheric correction of satellite pictures was evaluated in the test area Friese Fronten where the rich growth of algae is investigated. The selected test data are LANDSAT-5 TM satellite pictures, supplemented by measurement onboard the research ship Tyro. The correction method uses spectroradiometer data to estimate the atmospheric composition during the satellite passage. The obtained correction parameters are not adequate due to the problems with the measurement setup, cloud cover degree, calibration factors, and non-validated models. ESA

# 44 ENERGY PRODUCTION AND CONVERSION

Includes specific energy conversion systems, e.g., fuel cells; global sources of energy; geophysical conversion; and windpower.

For related information see also *07 Aircraft Propulsion and Power, 20 Spacecraft Propulsion and Power,* and *28 Propellants and Fuels.*

**N90-23787#** Boeing Aerospace Co., Seattle, WA.
**COMPUTER TOMOGRAPHY OF THERMAL BATTERIES AND OTHER CLOSED SYSTEMS Interim Report, Aug. 1988 - Jun. 1989**
Richard H. Bossi Dec. 1989 63 p
(Contract F33615-88-C-5404; AF Proj. 3153)
(AD-A218379; WRDC-TR-89-4113) Avail: NTIS HC A04/MF A01 CSCL 10/4

Under a preliminary testing task assignment of the Advanced Development of X Ray Computed Tomography Applications program, computed tomography (CT) was applied to several types of closed system components. For this task, closed system components were defined as components which were closed structurally such that the interior could not be inspected except by penetrating radiation. The primary testing emphasis was with thermal batteries. The units are hermetically sealed with a number of internal components and materials whose proper assembly and orientation is essential for successful operation. In addition to thermal batteries, several other mechanical and electromechanical

closed systems were examined, including: missile and rocket launch secure and enable systems, and aircraft mechanical actuators and drive subsystems. GRA

**N90-23788#** Case Western Reserve Univ., Cleveland, OH. Dept. of Chemistry.
**VERY HIGH FREQUENCY MEASUREMENTS OF GEOMETRIC FACTORS IN TRANSMISSION LINE LEAD ACID CELLS Interim Report**
B. D. Cahan, R. R. Adzic, M. L. Daroux, and E. B. Yeager 15 Mar. 1990 31 p
(Contract N00014-86-C-0808)
(AD-A219463; TR-3) Avail: NTIS HC A03/MF A01 CSCL 10/3

Strip-line cells using lead strips 1 cm wide with sulfuric acid electrolyte were constructed with lengths of 10, 25, and 100 cm with several electrode spacing to test the predictions of the theoretical models under real cell conditions. The impedance of these cells has been measured over a wide frequency range (0.1 to 10(exp 7) Hz). New experimental techniques had to be developed for this task including the use of a new potentiostat (BC 2000) which has a full current slew rate of 4 microseconds. Since the usual current measuring resistors are too inductive for use at these extreme frequencies, currents were measured with a high speed current probe (which has a bandwidth of 50 MHz). The results show clearly the effects of the inductance of the cell. These effects are clearly visible at frequencies as low as 100 Hz. The results suggest that the use of large battery systems in the short time domain will be seriously limited by these effects. GRA

**N90-23789#** City Univ. of New York, Brooklyn. Dept. of Physics.
**EVALUATION OF THE STATE OF CHARGE OF BATTERY ELECTRODES WITH ac IMPEDANCE TECHNIQUES Report, 1 Aug. 1988 - 30 Jul. 1989**
Micha Tomkiewicz 30 Jul. 1989 7 p
(Contract N00014-81-K-0339)
(AD-A219561) Avail: NTIS HC A02/MF A01 CSCL 10/3

The correlations between the state of charge (SOC) of battery electrodes and the frequency dispersion of their impedance are studied. Zinc and silver electrodes were investigated in smooth and porous configurations, under conditions similar to conventional battery applications. The emphasis was on the evolution of random morphologies of a composite dielectric as function of the SOC and the ability of impedance measurements to quantify these changes. Theoretical and experimental tools are sought that will help quantify the random morphologies and correlate them with the interfacial chemistry and wish to determine whether phase transitions in transport properties take place during the charge/discharge cycles and how best they can be categorized to provide predictive power for the transport properties in these systems. GRA

**N90-23790#** Aerospace Corp., El Segundo, CA. Chemistry and Physics Lab.
**INTERDIGITATED BACK CONTACT SILICON SOLAR CELL ANALYSIS AND DESIGN RECOMMENDATIONS FOR SPACE USE**
Dean C. Marvin and Sharon L. Froedge 30 Sep. 1989 31 p
(Contract F04701-85-C-0086)
(AD-A220414; TR-0088(3945-01)-1; SSD-TR-90-04) Avail: NTIS HC A03/MF A01 CSCL 10/2

The Interdigitated Back Contact (IBC) solar cell is a relatively new design which has shown unprecedentedly high efficiencies. Silicon Interdigitated Back Contact cells have been fabricated that show greater than 25 percent efficiency at 100 suns Air Mass 1.5. This is far superior to conventional silicon concentrator cells which are approximately 18 percent efficient. The purpose of this report is to describe briefly the differences between this technology and conventional cells, demonstrate a near optimum design achieved by two-dimensional numerical simulation, and assess the utility of these cells for space application. The end of life (EOL) performance of this cell design in the radiation environment of space is a critical issue since the high efficiency of the design is predicated on the use of very high quality, long-diffusion length silicon. The radiation-induced degradation of this material is expected to lead to severe efficiency losses. The optimization of cell design to minimize these losses was carried out using a modified version of the two-dimensional PISCES semiconductor simulator. The final designs presented here show that the performance of IBC cells in space can significantly exceed that of conventional cells. GRA

**N90-23791#** Spire Corp., Bedford, MA.
**RADIATION-HARD-HIGH-EFFICIENCY InP SPACE SOLAR CELL DEVELOPMENT Quarterly Progress Report, 12 Nov. 1989 - 11 Feb. 1990**
Mar. 1990 29 p
(Contract N00014-89-C-2148)
(AD-A220500; SPIRE-QR-10120-03) Avail: NTIS HC A03/MF A01 CSCL 10/2

The persistent problems which had led to abnormally low voltages and fill factors since the beginning of the contract were solved, allowing production of cells with consistently high efficiencies. The first delivery, of 30 4 sq cm cells, was made; the efficiencies of these cells (according to Spire measurements) ranged from 15.7 to 18.9 percent. These efficiencies are essentially equal to those measured in 1987 on Spire epitaxial/implanted cells, which are apparently still a record for the material. These new cells, therefore, would represent the highest efficiency for an all-epitaxial structure as well as the highest efficiency for a large cell. The sudden jump in efficiencies shows that the work done over the past six months on developing advanced thin emitters and refining the processing sequence has been fruitful. Increased collection efficiency due to the emitter improvements described in the last report contributed to the high efficiency of these cells, and simplification of the fabrication process made it possible to produce them on schedule. GRA

**N90-23792#** Aeronautical Research Inst. of Sweden, Stockholm. Dept. of Aerodynamics.
**AEROELASTIC AND STABILITY BEHAVIOUR OF THE WTS 3 MAGLARP WIND TURBINE. CALCULATIONS AND COMPARISONS WITH TESTS**
Magnus Soederberg Sep. 1989 9 p Sponsored by Swedish National Energy Administration
(FFA-TN-1989-23; ETN-90-96600) Avail: NTIS HC A02/MF A01

The method of branch modes and modal reduction technique is used in the aeroelastic analysis of a large wind energy converter, WTS 3 Maglarp, in Sweden. The results show among many things an unstable yaw behavior due to the flexible yaw system. Comparisons between the computer analyses and measurement campaigns show a good agreement when induced velocities are included in the analysis. ESA

# 45 ENVIRONMENT POLLUTION

Includes atmospheric, noise, thermal, and water pollution.

**N90-23793#** Agricultural Research Service, Phoenix, AZ. Water Conservation Lab.
**EFFECTS OF AIR TEMPERATURE ON ATMOSPHERIC CO2-PLANT GROWTH RELATIONSHIPS**
Stephen G. Allen, Sherwood B. Idso, Bruce A. Kimball, Jeffrey T. Baker, L. H. Allen, Jr., Jackson R. Mauney, John W. Radin, and Michael G. Anderson (Arizona State Univ., Tempe.) Apr. 1990 61 p
(Contract DE-AI01-81ER-60001)
(DE90-010159; DOE/ER-0450T) Avail: NTIS HC A04/MF A01

The carbon dioxide concentration of the earth's atmosphere is increasing and expected to double some time during the middle of the next century. In addition, climate models predict that due to the greenhouse effect, increased atmospheric CO2 may cause

a warming of the earth's surface of 1.5 to 4.5 C. The separate effects of atmospheric CO2 concentration and temperature on plant processes has been studied extensively. In general, a doubling of CO2 results in about a one-third increase in productivity of C3 plants, although a wide range of responses have been reported. This report reviews research concerned with the CO2 by temperature interaction effects on plants, with an emphasis on experiments conducted in outdoor, CO2-enriched environments. DOE

**N90-23794#** BBN Systems and Technologies Corp., Canoga Park, CA.
**UPDATING A DOSAGE-EFFECT RELATIONSHIP FOR THE PREVALENCE OF ANNOYANCE DUE TO GENERAL TRANSPORTATION NOISE Final Report, May 1987 - Jul. 1989**
Sanford Fidell, David S. Barber, and Theodore J. Schultz Dec. 1989 95 p
(Contract F33615-86-C-0530; AF Proj. 3037)
(AD-A219416; HSD-TR-89-009) Avail: NTIS HC A05/MF A01 CSCL 13/2

More than a decade has passed since a relationship between community noise exposure and the prevalence of annoyance was synthesized by Schultz (1978) from the findings of a variety of social surveys. The Air Force has come to rely heavily on this quantitative dosage-effect relationship for predicting aircraft noise-induced annoyance in environmental assessment documents. The effort described in this report updates the 1978 relationship with findings of social surveys conducted since its publication. Although the number of data points from which a new relationship was inferred more than doubled, the newly derived relationship differs little from the ones derived in 1978. GRA

**N90-23795#** Stockholm Univ. (Sweden). Dept. of Meteorology.
**THE DIURNAL OZONE CYCLE IN A CONIFEROUS FOREST: THE IMPORTANCE OF METEOROLOGY AND CHEMISTRY**
Christer Johansson, Jiang-Fen Zheng, and Henning Rodhe 21 Dec. 1989 29 p
(Contract SN-5315239-3)
(CM-75; ISSN-0280-445X; ETN-90-96579) Avail: NTIS HC A03/MF A01

A one dimensional model of turbulent diffusion and chemistry in the boundary layer is applied to analyze the diurnal variation of O3 concentration in a coniferous forest in Sweden. Meteorological observations such as wind speed, temperature, relative humidity and global radiation were used to describe the diurnal variation of mixing and dry deposition. The role of photochemistry and transport processes is investigated by dividing the dataset into two groups, representing conditions characterized by neutral and stable/unstable stratification, respectively. ESA

**N90-23796#** Swedish Defence Research Establishment, Umea.
**PUFFY: A PUFF DIFFUSION COMPUTER MODEL**
Kenneth Nyren, Torben Mikkelsen, and Soren Thykier-Nielsen (Risoe National Lab., Roskilde, Denmark ) Jun. 1989 36 p
(FOA-C-40251-4.5; ISSN-0347-2124; ETN-90-96591) Avail: NTIS HC A03/MF A01; Swedish Defence Research Establishment, S-901 82 Umeaa, Sweden, 50 Swedish crowns

The puff model PUFFY is an alternative to the Gaussian plume model to simulate dispersion in the atmosphere on a mesoscale range. Plume dispersion is calculated using consecutive gas clouds or puffs with Gaussian concentration distribution. PUFFY gives the user the possibility to make concentration computations with contributions from multiple sources in a variable wind field. Wind observation time series from multiple sites can be applied to compute a two dimensional flow field. The wind field is calculated using a 1/r squared interpolation scheme. Outputs from the model PUFFY are in the form of time dependent concentration fields, wind fields and puff position records. These files can be evaluated using graphics. ESA

**N90-23797*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
**SELECTIVE REMOVAL OF ORGANICS FOR WATER RECLAMATION Final Report**
Oliver J. Murphy, G. Duncan Hitchens, Lamine Kaba (Texas A&M Univ., College Station.), and Charles E. Verostko Jun. 1990 37 p
(Grant NAG9-350)
(NASA-TM-101890; NAS 1.15:101890) Avail: NTIS HC A03/MF A01 CSCL 13B

Electrooxidation is a means of removing organic solutes directly from waste waters without the use of chemical expendables. The feasibility of the concept for oxidation of organic impurities common to urine, shower waters and space habitat humidity condensates was demonstrated. Electrooxidation of urine and waste water ersatz was experimentally demonstrated. The electrooxidation principle, reaction kinetics, efficiency, power, size, experimental test results and water reclamation applications are described. Process operating potentials and the use of anodic oxidation potentials that are sufficiently low to avoid oxygen formation and chloride oxidation are also described. The design of a novel electrochemical system that incorporates a proton exchange membrane (PEM) electrolyte is presented based on parametric test data and current fuel cell technology. Author

# 46 GEOPHYSICS

Includes aeronomy; upper and lower atmosphere studies; ionospheric and magnetospheric physics; and geomagnetism.

For space radiation see *93 Space Radiation.*

**N90-23798*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
**ASTRONAUT'S GUIDE TO TERRESTRIAL IMPACT CRATERS**
R. A. F. Grieve, C. A. Wood, J. B. Garvin, G. McLaughlin, and J. F. McHone, Jr. (Arizona State Univ., Tempe.) Mar. 1988 89 p Prepared in cooperation with Lunar and Planetary Inst., Houston, TX
(NASA-TM-102902; NAS 1.15:102902; LPI-TRN-88-03) Avail: NTIS HC A05/MF A01 CSCL 08G

Impact cratering of the earth's surface is discussed and compared with lunar craters. The basic types found on earth are either simple craters or complex impact structures and basins. Meteorite fragments and shock metamorphism provide evidence of a crater's formation by meteorite impact. Known craters on earth are ordered by location and a few principal facts are given for each crater and the general terrain in which it is located. A satellite picture of each crater and maps identifying crater locations are provided. J.P.S.

**N90-23799** Georgia Inst. of Tech., Atlanta.
**METEOR RADAR STUDIES OF THE MESOPAUSE REGION AND NONLINEAR ATMOSPHERIC WAVES Ph.D. Thesis**
Jingwei Xiao 1989 218 p
Avail: Univ. Microfilms Order No. DA9005494

The Atlanta meteor radar data for the period of 1975 to 1986 was extensively investigated for studies of the dynamics of the mesopause region, where the dynamical structures were poorly understood because of lack of observational tools and the complexity of the theory. It is determined that the mean circulation is shaped by either the extratropical or equatorial circulations and related to the lower atmospheric meteorology by upward propagating gravity waves; this nonlinearity distinguishes the mesopause mean flow from the atmosphere. It is found that there is a significant coupling between the mesopause and the lower thermosphere. Studies of the meteorology of planetary waves and gravity waves and their relations with the mean circulation show that the wave spectra are not only affected by local circulation but are also correlated with high latitude transiency such as stratrospheric warmings. A strong correlation is found between the 11-year solar cycle, the QBO (Quasi-Biennial Oscillation), and

the Atlanta mesopause atmosphere. In part 2, the possible existence of nonlinear long waves in certain atmospheric environments is discussed. Dissert. Abstr.

**N90-23800** California Univ., Davis.
**TROPICAL-EXTRATROPICAL INTERACTION IN A MODEL ATMOSPHERE Ph.D. Thesis**
James Thomas Murphree 1989 107 p
Avail: Univ. Microfilms Order No. DA9002760

Seasonal scale interactions of the tropics and extratropics in response to tropical heating anomalies are explored in a simplified global model atmosphere with realistic basic states. The model response consists of: (1) long planetary waves propagating poleward and westward; (2) shorter planetary waves propagating poleward and eastward; and (3) meridionally trapped planetary waves propagating eastward in strong jet regions. The three responses are very dependent on the basic state structure. Subtropical westerlies exert a strong influence on the extratropical response. During northern winter, areas of weakness in the subtropical westerlies are sectors through which much of the tropical-extratropical communication occurs. This communication is inhibited in areas of strong subtropical jets. Further, these jet regions are the dominant energy sources for the response. A linearized version of the model indicates that the qualitative structure of the response is determined by linear dynamics. Nonlinear interactions along strong jets are important contributors to the response strength. The extratropical response is weakly sensitive to the location of the tropical forcing, due to the strong control exerted by the subtropical flow on the generation and the meridional propagation of planetary waves. These results provide new insights into the mechanisms and predictability of tropical-extratropical interaction in the real atmosphere. Author

**N90-23801** Princeton Univ., NJ.
**NONLINEAR INTERNAL GRAVITY WAVE CRITICAL LAYERS Ph.D. Thesis**
Kevin Graham Lamb 1989 161 p
Avail: Univ. Microfilms Order No. DA9012722

Internal gravity critical layers occur where the phase velocity of the wave is equal to the velocity of mean flow. For waves in the atmosphere generated by flow over a mountain they are located at heights where the horizontal wind reverses direction. Critical layers are an important phenomenon because they can reflect, absorb and transmit waves. Linear theory for the initial value problem shows that critical layers are very effective absorbers initially. After a short time linear theory breaks down. For atmospheric and oceanic applications a nonlinear extension of the theory is desired. Periodic 2-D steady state solutions of the nonlinear critical layer problem are sought via a combination of asymptotic and numerical techniques. The critical layer consists of a central region of closed streamlines in which the fluid has constant density and vorticity. This central region is surrounded by nonlinear regions of open streamlines. The critical layer lies between two linear regions. Below the critical layer the flow is forced by a periodic hill. The fluid is strongly stratified throughout the domain, allowing the imposition of a radiation condition far above the critical layer. Inviscid solutions for which the only flow discontinuities allowed are across the boundaries of the central region are considered. It is shown that, except in special cases, only solutions with continuous velocity and density can be constructed. Solutions with viscous layers along the boundaries of the central region to smooth out velocity and density discontinuities are also sought. Through the use of a simplified viscous layer model problem it is conjectured that the periodic problem is ill-posed. Dissert. Abstr.

**N90-23802#** Tel-Aviv Univ. (Israel). School of Engineering.
**POLAR BEAR UV IMAGING OF AIRGLOW AND AURORA-IMAGE PROCESSING AND RESULTS Final Technical Report, Sep. 1987 - Aug. 1989**
Moshe Tur, Israel Osnovich, and Arnoldo Ravitz 24 Sep. 1989 67 p
(Contract F49620-87-C-0091)
(AD-A219480; GL-TR-89-0287) Avail: NTIS HC A04/MF A01 CSCL 04/1

In late 1986, AFGL launched the Polar BEAR satellite, which was designed for UV imagery of the northern pole region. The AIRS scanning ultraviolet photometer aboard the satellite provides images of day and night auroral structures of unprecedented spectral and spatial resolution at 2 working spectral windows simultaneously. It is necessary to apply geometric and photometric corrections to the image in order to enhance and map it onto the ionosphere. Furthermore, satellite attitude corrections are imperative to assure that image coordinates are properly rotated to the real-time body reference system. To the best knowledge of the authors, this project is the first one to fully include geometric and photometric corrections to VUV images of the ionosphere. GRA

**N90-23803#** Massachusetts Inst. of Tech., Cambridge. Earth Resources Lab.
**ANALYSIS OF REGIONAL PHASES USING THREE-COMPONENT DATA Final Report, 19 Aug. 1987 - 31 Aug. 1989**
M. NafiToksoez, Ari Ben-Menahem, Anton M. Dainty, Batakrishna Mandal, and Michael Prange 20 Nov. 1989 233 p
(Contract F19628-87-K-0054)
(AD-A219482; AFGL-TR-89-0310) Avail: NTIS HC A11/MF A02 CSCL 08/11

The objective was to conduct basic research on the propagation of seismic energy at regional (100 to 1000 km) distances for purposes of monitoring underground nuclear explosions. The problems studied were scattering of seismic body waves by rough interfaces, the effect of anisotropic media on the seismic radiation from sources embedded in them, and the attenuation of crustal phases. This Final Report consists of preprints of four papers on these subjects. The first concerns scattering of body waves by rough interfaces. A plane wave (P or S) incident on a rough interface is considered. If the interface were plane the solution would be given by the classical reflection and transmission coefficients from which scattered field under the approximations that the interfac height perturbation is much smaller than a wavelength and the interface slope perturbations are much less than unity. The solution may be expressed as three-dimensional scattering kernels that allow reconstruction of scattered reflected and transmitted fields. GRA

**N90-23804*#** Iowa Univ., Iowa City. Dept. of Physics and Astronomy.
**DIAGNOSIS OF AURORAL DYNAMICS USING GLOBAL AURORAL IMAGING WITH EMPHASIS ON LARGE-SCALE EVOLUTIONS**
John D. Craven and Louis A. Frank Sep. 1989 62 p Submitted for publication Original contains color illustrations
(Contract NAG5-483; NGL-167-001-002; N00014-85-K-0404)
(NASA-CR-186623; NAS 1.26:186623; AD-A219668; U-of-Iowa-89-21) Avail: NTIS HC A04/MF A01 CSCL 04/1

The spatial extent of the auroral oval and polar cap for typical auroral conditions covers an area of about Mkm2, for which a minimum of more than 20 well-placed ground stations is required for full spatial coverage, even if significant difficulties such as sunlight, moonlight, geography, and meteorology are neglected. As shown here, auroral imaging with high-altitude spacecraft provides substantial advantages relative to ground-based techniques. Variations in the dimensions of the auroral oval with changes in the sign of the Z component of the interplanetary magnetic field (IMP) are easily observed. Auroral luminosities all along the auroral oval increase within minutes following arrival at the magnetosphere of a shock in the interplanetary medium. It appears that the dawn-dusk motion of the large-scale transpolar arc of a theta aurora observed in the northern (southern) polar cap is in the same (opposite) direction as the By component of the IMF. It is shown that the onsets of auroral substorms occur within a range of less than 3.5 hours of magnetic local time centered at 2250 MLT. This is nearly identical to the statistically determined

location for the initial response to substorm onset at the orbits of geosynchronous spacecraft. The auroral bulge does not always expand symmetrically in the east-west direction from the position of substorm onset, but can progress preferentially into either the evening or morning sector. GRA

**N90-23805#** Airborne Research Associates, Weston, MA.
**ATMOSPHERIC TURBULENCE MEASUREMENTS IN SUPPORT OF ADAPTIVE OPTICS TECHNOLOGY Final Technical Report, Dec. 1985 - Dec. 1987**
R. M. Markson, B. W. Anderson, C. W. Fairall, D. W. Thomson, A. B. White, and W. J. Syrett Mar. 1989 342 p
(Contract F30602-86-C-0021; AF Proj. D174)
(AD-A220445; RADC-TR-89-289) Avail: NTIS HC A15/MF A02 CSCL 04/1

This report is concerned with the relation of meteorological conditions to parameters and processes that influence the optical propagation properties of the turbulent atmosphere. The approach is centered around the use of aircraft and surface based remote sensors to investigate the relationship of the refractive index structure function parameter, Cn-sq, to various meteorological variables and to generally evaluate the accuracy of measurements of Cn-sq by in situ and remote means. The relationship of the atmospheric turbulence profile to the synoptic context and the use of physical models to predict the profile using standard meteorological profile data was also investigated. The study features two modes of data acquisition: (1) continuous archiving of 1 hr average wind profiles and turbulence levels with VHF Doppler radar profiles, and (2) high time resolution aircraft measurements in association with other measurements (ground based optical scintillometers, thermosondes, radar profilers, and Doppler sodar profilers). In one case all of the surface based systems were assembled in an intensive campaign given the acronym EWAK. The atmospheric turbulence profiles and resultant optical propagation parameters have been found to be strongly influenced by synoptic conditions. In particular, the turbulence is substantially affected by the strength and location of jet stream. A very strong correlation between wind shear (which is maximum above and below the core of the jet) and pilot reports of turbulence was found. GRA

**N90-23806#** Air Force Geophysics Lab., Hanscom AFB, MA.
**THE IMPORTANCE OF ADIABATIC VARIATIONS IN TRAPPED PARTICLE DISTRIBUTIONS OBSERVED BY THE SCATHA SATELLITE Interim Scientific Report, Mar. 1987 - Feb. 1989**
J. N. Bass (RADEX, Inc., Bedford, MA.), M. S. Gussenhoven, and R. H. Redus 29 Nov. 1989 39 p
(AD-A220859; GL-TR-89-0233; ERP-1048) Avail: NTIS HC A03/MF A01 CSCL 04/1

Fluxes of trapped 20 keV-1 MeV electrons and ions observed by SCATHA from 5 to 8 R sub E are analyzed for a magnetically quiet and subsequent disturbed period to determine the contribution adiabatic variations make to the observed large variations. The magnetic field is modeled by a dipole distorted by the sum of an azimuthally symmetric and an asymmetric perturbation, which perturbations are empirically determined functions of time. Distribution functions for the disturbed period are predicted from those observed in the quiet period, assuming conservation of the three adiabatic invariants for magnetically trapped particles. The disturbance discussed here is observed during the ascending portion of the SCATHA orbit. The disturbance is first encountered when SCATHA crosses L=6.2R sub E, MLT=2140. It is characterized by a systematic weakening in the plasma sheet magnetic field and concurrent dropouts in the 90 deg pitch angle high energy electron and ion fluxes. The electron fluxes and the magnetic field remain low for the remainder of this ascending leg, but the ion fluxes recover somewhat for L is greater than 7R sub E. The IMF B sub z is small but steadily northward for over 24 hours preceding this period. The solar wind velocity decreases at a slow rate before and during this period, while the solar wind ion density is steadily increasing. For magnetic field decompression, the theory based on conservation of the adiabatic invariants predicts deceleration of equatorially mirroring particle. GRA

**N90-23807** Danish Meteorological Inst., Copenhagen. Geophysics Div.
**GODHAVN (GREENLAND) GEOPHYSICAL OBSERVATORY: MAGNETIC RESULTS, 1984**
1988 74 p
(ISBN-87-7478-289-4; ETN-90-96569) Avail: Danish Meteorological Inst., Div. of Geophysics, Lyngbyvej 100, DK-2100 Copenhagen, Denmark

Results of the geomagnetic measurements carried out at the observatory in 1984 are presented. The photographic La Cour and digital fluxgate magnetographs are described. The orientation of the fluxgate sensors and work on the magnetographs/accommodation are discussed. Absolute measurements and reduction formulas are explained. Yearbook processing, quality of data and data distribution are discussed. ESA

**N90-23808#** Ohio State Univ., Columbus. Dept. of Geodetic Science and Surveying.
**DETERMINATION OF THE GRAVITY DISTURBANCE BY PROCESSING THE GRAVITY GRADIOMETER SURVEYING SYSTEM: PROCESSING PROCEDURE AND RESULTS Scientific Report No. 8**
Yan Ming Wang Aug. 1989 30 p
(Contract F19628-86-K-0016; AF Proj. 7600)
(AD-A219992; GL-TR-89-0318; SR-8) Avail: NTIS HC A03/MF A01 CSCL 08/5

The gravity gradiometer surveying system (GGSS) took the first flight in the Texas/Oklahoma area and the data were released in April, 1989. The main problem of processing the GGSS gradient data is that there is bias in the data. If the tie point values of the gravity gradient are available, then the bias can be removed from the GGSS gradient data by using crossover discrepancy adjustment. Since there are no tie point values of the gravity gradient, the free-air gravity anomaly was used as the tie point values. Two components of the GGSS gradient data T sub xz and T sub yz were integrated linearly into the vertical derivatives of the disturbing potential I sub z, the bias and tilt in the T sub z for each track were removed by combining the tie point values of the free-air anomaly in the test area. Finally, the T sub z was recovered on the ground by using the fast Fourier transformation and least squares collocation. The results were compared with the free-air anomalies in the test area. The difference between the T sub z and the free-air anomaly has the root mean square value 5.8 mgal. This result is reasonable in comparison with the accuracy + or - 10 E of the GGSS gradient data. A crossover discrepancy analysis indicated that the GGSS gradient data could have the accuracy about 10 Eotvos. GRA

**N90-23809#** Air Force Geophysics Lab., Hanscom AFB, MA. Ionospheric Physics Div.
**AN ANALYTIC/EMPIRICAL MODEL OF THE MIDDLE AND LOW LATITUDE IONOSPHERE Interim Scientific Report**
J. M. Forbes, D. N. Anderson, M. Codrescu, and P. P. Batista (Instituto de Pesquisas Espaciais, Sao Paulo, Brazil ) 31 Mar. 1989 54 p
(Grant AF-AFOSR-0048-85; AF Proj. 2310)
(AD-A220004; GL-TR-89-0096; ERP-1027) Avail: NTIS HC A04/MF A01 CSCL 04/1

An improved analytic/empirical model of F-layer plasma density is developed by modifying the Chiu (1975) model so as to: (1) better approximate middle latitude F-layer peak heights (hmF2's) as derived from ionosonde data, and (2) better model features such as the post-sunset rise in the F-layer peak height, and the equatorial anomaly maxima in plasma density near + or - 15 geomagnetic latitude. The latter is accomplished by applying analytic low-latitude correction as derived from differences between the Chiu model and the SLIM model of Anderson et al. Results of a numerical model are also presented that demonstrate the importance of these low-latitude plasma structures to the neutral dynamics of the thermosphere. GRA

**N90-23810#** Alaska Univ., Fairbanks. Geophysical Inst.
**A STUDY OF GRAVITY WAVE VARIABILITY, SATURATION, AND TURBULENCE GENERATION IN THE MESOSPHERE AND LOWER THERMOSPHERE Final Technical Report**
David C. Fritts 1989 5 p
(Contract N00014-86-K-0661)
(AD-A220018) Avail: NTIS HC A01/MF A01 CSCL 04/1

Our principal research objectives were to understand the characteristics of and the processes controlling the fluctuations of velocity, density, and optical properties due to wave and turbulence motions in the middle atmosphere. It was hoped that an increased understanding of these motions and their variability would lead to a better predictive capability for their influence on in situ and ground-based systems using this region in the future. Research progress was made on several fronts. Theoretical efforts focussed on wave propagation and saturation processes, the effects of varying stratification on wave saturation and wave transports of energy and momentum, and the influences of chemical recombination on ion and neutral fluctuations due to waves and turbulence. GRA

**N90-23811#** Boston Univ., MA. Center for Space Physics.
**IONOSPHERIC EQUIVALENT SLAB THICKNESS AND ITS MODELING APPLICATIONS Scientific Report No. 2**
Matthew Fox and Michael Mendillo Nov. 1989 46 p
(Contract F19628-86-K-0026)
(AD-A220105; GL-TR-89-0312; SR-2) Avail: NTIS HC A03/MF A01 CSCL 04/1

A database of equivalent slab thickness observations covering nearly two complete solar cycles has been obtained at a mid-latitude site (Hamilton, MA). This database has been studied for correlations between the various parameters as well as for dependencies on observable quantities. The mean variations of tau are described both qualitatively, in terms of changes to profile shapes, and quantitatively, in terms of a simple numerical model. A preliminary investigation of the day-to-day variations of tau is also described. The similarity of the mean numerical tau model to one obtained using data from a site in Wales (U.K.) suggests that longitude variations of tau may well be small at mid-latitudes. This property has in turn been used to convert a network of ionosonde observations to a database of TEC, for comparisons with a number of currently available ionospheric models. These same ionospheric models were also used to predict values of tau over Hamilton, MA, and the comparisons provided additional model validation. Adjustments to the model profiles were suggested in a couple of cases. GRA

**N90-23812#** Aerospace Corp., El Segundo, CA. Space Sciences Lab.
**A SURVEY OF EQUATORIAL MAGNETOSPHERIC WAVE ACTIVITY BETWEEN 5 AND 8 R(SUB E)**
Harry C. Koons and James L. Roeder 1 Mar. 1990 27 p
(Contract F04701-88-C-0089)
(AD-A220137; TR-0089(4940-06)-2; SSD-TR-90-03) Avail: NTIS HC A03/MF A01 CSCL 04/1

We report the results of a survey of ELV/VLF wave activity in the frequency range from 100 Hz to 5 kHz observed by the SCATHA satellite near the magnetic equator between 5 and 8 R sub E. The typical wave environment in this region is required to assess the role of each type of wave in transport processes, such as the pitch-angle diffusion of electrons, occurring in the outer magnetosphere. Hiss, discrete whistler-mode emissions, and electron cyclotron harmonic waves occur within the frequency range of the SCATHA VLF receiver. Hiss is predominantly observed between noon and dusk where the satellite frequently enters the plasmasphere. Discrete whistler-mode emissions occur over 60 percent of the time between 0300 and 1200 LT. A surprising result of the survey is the absence of activity in the local time sector from 18 to 21 h. No wave activity above the receiver noise level, 5 x 10 to the minus 7th power V/m-Hz1/2, was detected during 50 percent of the broadband data acquisitions in this region. GRA

**N90-23813*#** Wesleyan Univ., Middletown, CT. Dept. of Earth and Environmental Sciences.
**EROSIONAL DEVELOPMENT OF BEDROCK SPUR AND GULLY TOPOGRAPHY IN THE VALLES MARINERIS, MARS Final Report**
Peter C. Patton 1990 37 p
(Grant NAGw-0244)
(NASA-CR-180655; NAS 1.26:180655) Avail: NTIS HC A03/MF A01 CSCL 08G

Gully networks separated by resistant bedrock spurs are a common erosional feature along the escarpments that border the Valles Marineris. The resistant spur topography is best developed where the base of the slope is truncated by linear scarps interpreted as fault scarps. Regional variations in slope morphology imply that spur and gully topography undergoes a systematic progressive degradation through time associated with the erosional destruction of the basal fault scarps. The comparative morphometry of the divide networks indicates that the density of the spur networks and the number of first-order unbranched spurs decreases as the basal slope break becomes more sinuous. Abstraction of the spurs occurs through regolith storage in adjacent gullies at the slope base and the most degraded slope forms are entirely buried in talus. The basal fault scarps apparently control regolith transport by allowing debris to drain from the slope. As these basal scarps decay the slope base becomes increasingly sinuous and the slopes become transport limited. Dry mass-wasting may be the most important process acting on these slopes where a continually lowered base level is required to maintain the spur topography. In contrast to the Martian slopes, range front fault escarpments in the western U.S. show no systematic trend in spur network geometry as they are eroded. These weathering limited slopes are controlled by the more efficient removal of regolith through fluvial processes which rapidly create quasi-equilibrium drainage networks. Author

**N90-23814#** Technische Univ., Delft (Netherlands). Vakgroep Mathematische en Fysische Geodesie.
**THE VERY LONG BASELINE INTERFEROMETRY (VLBI) FUNCTIONAL MODEL AND THE RELATION WITH TECTONIC MOTIONS Thesis [HET FUNCTIEMODEL BIJ VERY LONG BASELINE INTERFEROMETRY EN DE RELATIE MET TEKTONISCHE BEWEGINGEN]**
Ronald E. Molendijk Aug. 1988 74 p In DUTCH
(ETN-90-96694) Avail: NTIS HC A04/MF A01

The VLBI was used as estimation technique for tectonic motions. The functional model of the Delft VLBI software DEGRIAS was improved. The tectonic motions are described geologically; the geometric modeling with plate rotations vectors is described; and the relation with geodetic (VLBI) observations is outlined. The precision of the estimated tectonic parameters is discussed. Simulations show that the network condition, which is neglected in the study of individual baselines, is necessary to obtain an optimal result. ESA

**N90-23815#** Technische Univ., Delft (Netherlands). Faculty of Geodesy.
**TWO DIMENSIONAL FOURIER ANALYSIS OF THE EARTH GRAVITATIONAL FIELD USING THE PROGRAM PACKAGE TIM Thesis [TWEE-DIMENSIONALE FOURIERANALYSE VAN HET AARDSE ZWAARTEKRACHTSVELD GEBRUIKMAKEND VAN HET PROGRAMMAPAKKET TIM]**
J. G. A. Jansen Jun. 1989 50 p In DUTCH
(ETN-90-96696) Avail: NTIS HC A03/MF A01

The program package TIM for image processing was used for spectral analysis, in particular of the earth gravitational field. Fourier analysis using TIM is described. The multiplication and scaling factors have to be handled very carefully to calculate the results back to real life values. Rounding off errors always remain . Filtering in the frequency domain introduces complexity and makes the final results less precise. The main conclusion of this study is negative with respect to the Fourier transformation performances of TIM. A positive conclusion is that TIM is very well suited for representation purposes. ESA

# 47 METEOROLOGY AND CLIMATOLOGY

Includes weather forecasting and modification.

**N90-23816#** Oregon State Univ., Corvallis. Energy Resources Research Lab.
**THE EFFECTS OF CLIMATE CHANGE ON ENERGY PLANNING AND OPERATIONS IN THE PACIFIC NORTHWEST. VOLUME 1: OVERVIEW Final Report**
John E. Wade, Kelly Redmond, and Peter C. Klingeman Aug. 1989 56 p Prepared in cooperation with Bonneville Power Administration, Portland, OR
(Contract DE-BI79-86BP-63406)
(DE90-009464; DOE/BP-63406/7; BPA-89-29-Vol-1) Avail: NTIS HC A04/MF A01

This report, the first of two volumes, is an examination of Bonneville Power Administration's access to and use of climate information. Widespread concern about global warming and uncertainty about future energy scenarios underscore the influence of climate on energy planning and management. Refinement of scientific theories and computer data capabilities provide unprecedented opportunities for technical capability building and improved management decisions. BPA's decade of examining the availability and feasibility of wind energy has led to fundamental questions about the adequacy and potential of climate awareness. Volume 1 is an overview of the fingings of the research. The implications for energy planning are discussed and suggestions for further study to quantify the impacts of climate change on energy planning and operations are provided. DOE

**N90-23817#** Oregon State Univ., Corvallis. Energy Resources Research Lab.
**THE EFFECTS OF CLIMATE CHANGE ON ENERGY PLANNING AND OPERATIONS IN THE PACIFIC NORTHWEST. VOLUME 2: TECHNICAL BACKGROUND Final Report**
John E. Wade, Kelly Redmond, and Peter C. Klingeman Sep. 1989 152 p Prepared in cooperation with Bonneville Power Adm inistration, Portland, OR
(Contract DE-BI79-86BP-63406)
(DE90-009465; DOE/BP-63406/8; BPA-89-29-Vol-2) Avail: NTIS HC A09/MF A01

This report, the second of two volumes, is an examination of Bonneville Power Administration's access to and use of climate information. Widespread concern about global warming and uncertainty about future energy scenarios underscore the influence of climate on energy planning and management. Refinement of scientific theories and computer data capabilities provide unprecedented opportunities for technical capability building and improved management decisions. BPA's decade of examining the availability and feasibility of wind energy has led to fundamental questions about the adequacy and potential of climate awareness. This inquiry prompted a five-month survey by Oregon State University's Energy Resources Research Laboratory (ERRL), with extensive input from the Oregon Water Research Institute and the Oregon State Climatologist. Investigators from the ERRL have worked with BPA since 1975, gaining uncommon insight to needs and concerns of utilities in general and BPA in particular. DOE

**N90-23818#** Oregon State Univ., Corvallis. Dept. of Mechanical Engineering.
**SEASONAL WEATHER FORECAST VERIFICATION**
John E. Wade, Stel N. Walker, and Robert W. Baker Feb. 1990 24 p Prepared in Bonneville Power Administration, Portland, OR
(Contract DE-BI79-86BP-63406)
(DE90-009467; DOE/BP-63406/10; BPA-89-31) Avail: NTIS HC A03/MF A01

The purpose of this report is to provide an assessment of how accurate seasonal weather forecasts are at the present and report on the prospects for forecast improvement. The report will discuss how the seasonal forecasts are made and used. The verification scheme used will also be described along with the results of the verification. The results will indicate that the accuracy of seasonal forecasts is not high. However, there is some evidence that forecast skill is better at specific sites and particularly for the winter season. New relationships observed between sea level temperatures, El Nino, and Pacific Northwest climate offer hope of better seasonal forecasts. The scope of this study did not allow investigation of the important aspect of the value of the seasonal forecast. DOE

**N90-23819#** Naval Postgraduate School, Monterey, CA. Dept. of Meteorology.
**APPLICATION OF THE LAGGED-AVERAGED TECHNIQUE TO TROPICAL CYCLONE TRACK PREDICTIONS M.S. Thesis**
A. Ben Bacon Jun. 1989 44 p
(AD-A218389) Avail: NTIS HC A03/MF A01 CSCL 04/2

The lagged-averaged forecast (LAF) technique applied to tropical cyclone track prediction is a weighted sum of recent forecasts that were started from initial conditions at various times lagging the start of the forecast period. The goal is to reduce the track forecast error at t + 24 h. Two tests of the LAF approach are presented to demonstrate feasibility. The first test uses the nine CLIPER forecasts initiated at 24, 30, 36, 42, 48, 54, 60, 66, and 72 h prior to the common verifying time. In this test, the mean 24-h forecast error is reduced by 8 percent relative to the 24-h CLIPER forecast above. In the second test, the modified LAF involves only the five CLIPER forecasts initiated at 24, 36, 48, 60, and 72 h prior to the verifying time. However, the 36-h through 72-h CLIPER forecasts are first modified using statistical regression equations that include predictors related to new track information since these forecasts were initiated. Significant reductions in the track forecast error result from these statistical adjustments. The modified LAF applied to an independent sample results in a reduction from 189 km to 124 km in the mean 24-h forecast error or a reduction of 34 percent. This is a significant improvement because the JTWC mean 24-h forecast error for the last four years is approximately 210 km. The standard deviations are significantly reduced from 118 km to 69 km. GRA

**N90-23820#** Air Force Inst. of Tech., Wright-Patterson AFB, OH.
**EXAMINATION OF MICROBURST DEVELOPMENT IN COLORADO THUNDERSTORM FOR THE 5 AUGUST 1982 CASE M.S. Thesis**
William Edward McNamee 1989 154 p Prepared in cooperation with Saint Louis Univ., MO.
(AD-A218478; AFIT/CI/CIA-89-047) Avail: NTIS HC A08/MF A01 CSCL 04/2

Dual-Doppler radar data were collected near Denver, CO during the summer of 1982 to study the phenomenon of microbursts within the boundary layer. Horizontal and vertical fields of reflectivity, vertical velocity, perturbation temperature, and pressure are obtained from the radar data to assist in this microburst study. Three time periods on 5 August are used to detail the chronological development of microbursts: 1845, 1847, and 1850 MDT. The fields of perturbation pressure and temperature are derived from the three-dimensional wind field using a thermodynamic retrieval method based on the momentum equations. Inclusions of local time tendency terms in the momentum equations will increase resolution of these fields. During the 1845 to 1850 window, there are two microbursts, and one downdraft whose outflow does not extend to the surface. The two microbursts are in close proximity to each other, so the outflow from one results in upward vertical motion that helps lift surface moisture to condense at upper levels and help sustain the downdraft intensity via precipitation loading. GRA

**N90-23821#** Naval Postgraduate School, Monterey, CA.
**A DESCRIPTION OF TROPICAL CYCLONE RECURVATURE IN TERMS OF ISENTROPIC POTENTIAL VORTICITY M.S. Thesis**
Andrew P. Boerlage Jun. 1989 70 p
(AD-A218482) Avail: NTIS HC A04/MF A01 CSCL 04/2

Isentropic potential vorticity (IPV) fields calculated from the Navy Operational Regional Atmospheric Prediction System are analyzed to determine their usefulness as an aid to tropical cyclone recurvature forecasts. The IPV fields associated with Typhoon Nelson are calculated on a 80 km grid for the period 0000 UTC 4 October to 0000 UTC 7 October 1988. In this preliminary study,

IPV advection fields and the horizontal and vertical structure of the bogus vortex are examined to determine their contributions to the model forecast. The extremely broad bogus vortex is found to distort the IPV fields and cause regions of negative IPV, which is believed to result in inertial instability. Approximately 36 h are required for the model to adjust to the initial imbalance in the mass and wind fields. It appears that the unrealistic bogus vortex representation may have degraded the early portions of the model forecast. Analysis of IPV advection fields each 12 h during the NORAPS model integration showed that storm movement is primarily due to the influence of self-advection and the large-scale steering flow. During later periods other advective features associated with adjacent synoptic systems begin to influence the storm movement. Forecasters with access to such IPV fields may be able to evaluate the likely validity of the model forecast of recurvature. GRA

**N90-23822#** Massachusetts Inst. of Tech., Cambridge. Lincoln Lab.
**USE OF CLUTTER RESIDUE EDITING MAPS DURING THE DENVER 1988 TERMINAL DOPPLER WEATHER RADAR (TDWR) TESTS Project Report, 1987-1988**
Daniel P. Hynek 25 Jan. 1990 72 p
(Grant DTFA01-L-83-4-10579)
(AD-A218696; ATC-169; DOT/FAA/PS-89/4) Avail: NTIS HC A04/MF A01 CSCL 17/9

The Lincoln Laboratory Terminal Doppler Weather Radar (TDWR) testbed operated in Denver, CO in 1987 to 1988. This radar is a prototype of the wind shear detection radars scheduled to be installed by the FAA to provide warnings of possibly hazardous wind shear conditions in airport terminal areas. To obtain the required coverage at low altitudes (down to 100 to 200 meters above ground level), the antenna beam is required to scan at or very near the earth's surface. Strong ground clutter returns at these low elevation angles present a major problem in the detection of low reflectivity wind shear signals and pose a significant challenge to the mission of these radars. To address this problem, steps along several fronts are taken to mitigate the effects of clutter contamination. These include the use of narrow pencil-beam antennas to minimize ground illumination, suppression by high-pass clutter filters, and the use of clutter residue map editing. This report deals with the latter step, and focuses on the clutter environment experienced at the testbed site during April to October 1988 and its effects on clutter residue map usage. GRA

**N90-23823#** Coastal Engineering Research Center, Vicksburg, MS.
**COASTAL FIELD DATA COLLECTION PROGRAM. HURRICANE GILBERT STORM SURGE DATA Final Report**
Andrew W. Garcia Feb. 1990 31 p
(AD-A218752; CERC-MP-90-1) Avail: NTIS HC A03/MF A01 CSCL 04/2

Hurricane Gilbert is the most intense Atlantic hurricane on record. Although Gilbert did not make landfall on the U.S. coastline, because of its intensity it no doubt will be carefully studied. To those investigating storm surges, wave setup, and other coastal processes, hydrographic data from such a storm obtained at exposed coastal sites are of significant value. Contained herein are hydrographs acquired at 16 coastal sites during the passage of Gilbert through the Gulf of Mexico. A brief meteorological description of Gilbert also is included. A poststorm inspection was conducted by a Coastal Engineering Research Center (CERC) field team in the vicinities of Corpus Christi and Port Isabel, Texas. Coastal erosion and damage in these areas were minimal considering the severity of the hurricane. Selected representative photographs taken during the survey are also included. GRA

**N90-23824#** Naval Postgraduate School, Monterey, CA.
**A CASE STUDY OF EXPLOSIVE CYCLOGENESIS IN THE EASTERN PACIFIC OCEAN 14 TO 17 DECEMBER 1987 M.S. Thesis**
Jan Curtis Sep. 1989 70 p
(AD-A219543) Avail: NTIS HC A04/MF A01 CSCL 04/2

An explosive cyclogenesis event that occurred in the eastern Pacific Ocean on 14 through 17 December 1987 is investigated using the National Meteorological Center (NMC) final analyses and Geostationary Operational Environmental Satellite (GOES) digital imagery. Forecasts for this cyclone by the Navy Operational Global Atmospheric Prediction System (NOGAPS 3.0) and NMC Nested Grid Mesh (NGM) forecasts initialized at 12 UTC 14 December are also evaluated. Quasi-Langrangian budgets of mass and vorticity are computed to understand the factors responsible for the development of this intense cyclone. The initial surface development occurs within a strong baroclinic southeast of a significant short-wave trough aloft. Rapid intensification is accompanied by large cyclonic vorticity advection in the upper troposphere as the surface cyclone moves under the divergent quadrant of a 250 mb jet streak. A key element in this development is the superposition between the pre-existing surface low and upper level short wave trough in a favorable weak stability environment. These observations support earlier studies that upper level forcing acts as a critical catalyst in initiating eastern ocean explosive development. GRA

**N90-23825#** Naval Oceanography Command Detachment, Asheville, NC. National Climatic Data Center.
**US NAVY HINDCAST SPECTRAL OCEAN WAVE MODEL CLIMATIC ATLAS: MEDITERRANEAN SEA Final Report**
Peter M. Steurer Jan. 1990 322 p Sponsored by Naval Oceanography Command, Bay Saint Louis, MS
(AD-A219755; NAVAIR-50-1C-557) Avail: NTIS HC A14/MF A02 CSCL 04/2

This atlas contains climatological summaries for seven parameters based on modeled data. Included are wind speed and direction, significant wave height, wave direction, wave slope parameter, modal wave period, and directionality of the waves. The last three parameters have not appeared in previous U.S. Navy climatological atlases, because they cannot be directly derived from visual observations. This atlas provides the design, scientific and operational communities with a detailed representation of the overall wave climate of the Mediterranean Sea. GRA

**N90-23826#** Naval Postgraduate School, Monterey, CA. Dept. of Meteorology.
**A DAY IN THE LIFE OF A WARM FRONT M.S. Thesis**
Susan A. Davies Dec. 1989 81 p
(AD-A220373) Avail: NTIS HC A05/MF A01 CSCL 04/2

Three numerical model simulations of cyclogenesis are compared to examine the role of boundary layer stratification in enhancing the components forcing the ageostrophic circulation of an idealized warm front. The Sawyer-Eliassen diagnostic equation is applied to examine the contributions of frictional forcing and diabatic heating, as well as confluent and shear geostrophic deformation, to forcing of the secondary circulation of a warm front. The surface heat and moisture flux distributions are varied in each case, to evaluate the effect on each component as well as the cyclogenesis. Results confirm previous studies that geostrophic deformation forces strong frontogenesis at the surface, and at mid-levels frontogenesis is weaker and forced primarily by latent heat release. Frontogenetical forcing is modified by small-scale frictional forcing and diabatic heating, which depend upon the surface and boundary layer processes. Although frictional forcing comprises less than 5 percent of total forcing of the warm front, it apparently enhances frontogenesis, partially due to indirect effects on other more dominant processes. The intensity of frictional forcing is strongly dependent on the surface heat flux distribution and track of the cyclone relative to the sea-surface temperature gradient. In the absence of surface fluxes, frictional forcing is negligible. Surface forcing due to diabatic heating is frontolytical, and reduces total forcing at low levels by about twenty percent. GRA

**N90-23827#** Naval Postgraduate School, Monterey, CA. Dept. of Electrical and Computer Engineering.
**A KALMAN FILTER WITH SMOOTHING FOR HURRICANE**

**TRACKING AND PREDICTION M.S. Thesis**
Asim Mutaf Dec. 1989 88 p
(AD-A220413) Avail: NTIS HC A05/MF A01 CSCL 04/2

The performance of a Kalman filter used to track a hurricane was substantially improved by implementing a fixed interval smoothing algorithm. This tracking routine was designed and implemented in a microcomputer program. Several tracking scenarios were simulated and analyzed. Actual storm tracks obtained from the Joint Typhoon Warning Center in Guam, Mariana Islands, were used for this research. The application of the Kalman tracker to a tropical storm's wind speed tracking was also investigated by using the best track data and observed data. GRA

**N90-23828#** Air Force Systems Command, Wright-Patterson AFB, OH. Foreign Technology Div.
**HANDBOOK OF CLIMATE OF THE USSR. HUMIDITY OF AIR, ATMOSPHERIC PRECIPITATIONS, SNOW COVER**
7 Dec. 1989 288 p Transl. into ENGLISH of Spravochnik po Klimatu SSR (Leningrad, USSR), no. 27, pt. 4, 1968 p 1-213
(AD-A220454; FTD-ID(RS)T-1034-89) Avail: NTIS HC A13/MF A02 CSCL 04/2

The partial contents of this report include: short characteristic of the regime of humidification; explanations to the tables, humidity of air; atmospheric precipitation, and snow cover; and alphabetical index of stations. GRA

**N90-23829#** Florida State Univ., Tallahassee. Geophysical Fluid Dynamics Inst.
**A NUMERICAL STUDY OF THE SEASONAL VARIABILITY OF THE SOMALI CURRENT Ph.D. Thesis**
Tommy G. Jensen Feb. 1990 129 p
(Contract N00014-85-G-0240; NSF OCE-88-11316)
(AD-A220708) Avail: NTIS HC A07/MF A01 CSCL 08/3

A new numerical ocean model with multiple isopycnal layers is used to model the Indian Ocean. Normal vertical modes are used for initialization and in a new open boundary formulation. A 21 year integration with the Hellerman Rosenstein wind stress is made with a 3.5 layer and a 1.5 layer version of the model. The solution with three active layers reproduces the observed general circulation and variability of the Indian Ocean, e.g., the semiannual equatorial undercurrent and Yanai wave field in the west. Seasonal changes in the Somali Current system are studied in more detail. It is found that barotropic instability is likely to cause the generation of the Great Whirl in early June. We find good agreement between the observed undercurrents and the simulations in the model. Equatorial onshore flow below the thermocline in June is associated with the disappearance of the undercurrent below the Somali current. Return of this undercurrent in the fall is caused by instability of the Great Whirl. Experiments where the duration of the summer monsoon is extended show that the initial decrease in the magnitude of the Great Whirl is due to eastward and downward energy transfer rather that due to relaxation of the wind. The model solutions indicate that baroclinic instability plays an important role in the decay of the Great Whirl. The solution with a single active layer is essentially the same for the upper layer until the late summer monsoon, when the flow becomes unstable. GRA

**N90-23830#** Stockholm Univ. (Sweden). Dept. of Meteorology.
**CLOUD VOLUME STATISTICS FOR SOUTHERN SWEDEN**
Henning Rodhe and Ingrid Forsstroem 12 Oct. 1989 14 p
Sponsored by Swedish Air Force
(CM-77; ISSN-0280-445X; ETN-90-96580) Avail: NTIS HC A03/MF A01

The occurrence of clouds at various altitudes over southern Sweden was observed from aircraft by trained meteorologists during a one year period. A statistical analysis of these observations shows that the frequency of occurrence of clouds on a volume basis varies from above 40 percent in the 1 to 3 km level during Winter months to under 5 percent in the 5 to 10 km level during Summer. The average cloud volume below 4 km varies from 8 percent in Summer to 35 percent in Winter. The annual average cloudiness in the 0 to 5 km regions is estimated to be about 15 percent. ESA

**N90-23831#** Naval Postgraduate School, Monterey, CA.
**BAROTROPIC VORTEX ADJUSTMENT TO ASYMMETRIC FORCING WITH APPLICATION TO TROPICAL CYCLONE MOTION Ph.D. Thesis**
Lester E. Carr, III Sep. 1989 158 p
(AD-A219883) Avail: NTIS HC A08/MF A01 CSCL 04/2

A nondivergent, barotropic analytical model to predict steady tropical cyclone (TC) propagation relative to the large-scale environment is developed in terms of a self-advection process in which the TC is advected by an azimuthal wavenumber one gyre flow that results from TC-environment interaction. The model is comprehensive in that it includes the first-order effects of all of the dynamic influences that are presently understood to be important to barotropic propagation: gradients of planetary and environmental vorticity, changes in TC wind structure, and environmental windshear. An unforced version of the model is used to show that angular windshear in the symmetric TC circulation acts to damp perturbations from axisymmetry. Thus, steady propagation of TC-like barotropic vortices is a manifestation of a stable response to asymmetric forcing. To predict both the asymmetric gyre flow and the propagation it induces, the forced Barotropic Self-Advection Model (BSAM) is closed by seeking a particular pattern in the vorticity tendencies of the TC-environmental interaction flow. For realistic combinations of environmental vorticity gradients and linear windshear, the BSAM predicts propagation speeds and directions that are consistent with TC propagation characteristics observed in composite data. GRA

**N90-23832#** Air Force Geophysics Lab., Hanscom AFB, MA. Atmospheric Sciences Div.
**A COMPARISON OF LIGHTNING NETWORK DATA WITH SURFACE WEATHER OBSERVATIONS Interim Scientific Report**
H. A. Brown 9 May 1989 44 p
(AF Proj. 2688)
(AD-A220003; GL-TR-89-0129; ERP-1031) Avail: NTIS HC A03/MF A01 CSCL 04/2

The objective of this study was to demonstrate the effectiveness of a lightning detection network in providing a real-time data base from which automated observations of thunderstorms and lightning in the vicinity of an air base can be derived. A direction-finding cloud-to-ground lightning detection network (LDN) operated by the State Univ. of New York at Albany provided a data base of CG lightning locations in the northeastern United States for July to August, 1986. Copies of the original weather observation forms from 25 AF weather stations in the same area and time period provided a data base of thunderstorm and lightning observations for comparison. The lightning data base was analyzed for strike events located within 15 nm of each weather station. If the 15 minute period lapsed without another strike, the event was ended. Events were categorized as single- or multiple-strike events and the duration of the events tabulated. The weather observation data base was analyzed for thunderstorm events. The beginning time, ending time and duration of the events were tabulated as well as the type of lightning that was reported with each observation. Chronological comparison of the two data bases, using the weather observation data base as ground truth, generated 4 x 4 contingency tables of the combinations of thunderstorm-lightning events. Four parameters were derived from the statistical evaluation of the contingency tables: (1) Probability of detection; (2) False alarm rate; (3) Missed threat rate, and (4) Critical success index. GRA

**N90-23833#** Dugway Proving Ground, UT. Meteorology Div.
**ATMOSPHERIC TRANSPORT AND DISPERSION MODEL HIERARCHY, PART 2 Final Report, Oct. 1988 - Sep. 1989**
James F. Bowers, Elford G. Astling, and Gregory C. Dodd Nov. 1989 102 p Sponsored by Army Test and Evaluation Command, Aberdeen Proving Ground, MD

(AD-A220138; DPG-FR-90-704-Pt-2) Avail: NTIS HC A06/MF A01 CSCL 04/2

U.S. Army Dugway Proving Ground (DPG) conducted a methodology investigation to identify the numerical mesoscale modeling approach best suited for operational use in predicting DPG test grid winds up to 24 hours in advance. The selection criteria for the models were that they be: (1) existing models that have been successfully applied to mesoscale flows in complex terrain, (2) nonproprietary, and (3) available. The three models acquired during the study that satisfied these criteria were the U.S. Army Atmospheric Sciences Laboratory (ASL) model hierarchy, the Los Alamos National Laboratory (LANL) HOTMAC model, and Jan Paegle's BLAYER model. Initial work with the SIGMET model, the prognostic component of the ASL model hierarchy, identified a number of problems when the model was applied to DPG terrain with a grid resolution of 5 km. GRA

**N90-23834#** SRI International Corp., Menlo Park, CA. Atmospheric Science and Effects Program.
**DATA ANALYSIS OF A TWO-LIDAR EXPERIMENT Final Report, Sep. 1987 - Mar. 1990**
John M. Livingston and Edward E. Uthe Feb. 1990 53 p
(Contract DAAL03-87-K-0146)
(AD-A220289; ARO-25628.1-GS) Avail: NTIS HC A04/MF A01 CSCL 17/9

Lidar is a promising method for evaluating the optical and physical density distributions of obscurant clouds with high spatial and temporal resolution. However, single-lidar techniques may not completely penetrate dense obscurant clouds, and optical parameter assumptions necessary for inversion of lidar data can introduce unacceptable uncertainties in evaluated quantities. A two-lidar technique with each lidar observing the same optical path from opposite ends of the path may provide the means to quantitatively evaluate obscurant density parameters without the assumptions needed for analysis of single-lidar measurements. To test the two-lidar technique, SRI International (SRI) operated two van-mounted 1.06-mm wavelength lidar systems at White Sands Missile-Range (WSMR) during the period 6 May 1988 in conjunction with the Characterization, Evaluation, and Comparison of Army Transmissometer Systems (CECATS) program. The two lidars were positioned at opposite ends of a near-common propagation path, and each laser path was terminated by a target with near-uniform reflection properties. GRA

**N90-23835#** Surveillance Research Lab., Salisbury (Australia).
**TRANSMISSION OF INFRARED RADIATION THROUGH THE AUSTRALIAN ATMOSPHERE: PREDICTIONS USING THE LOWTRAN MODEL**
G. A. Findlay and D. R. Cutten Jul. 1989 46 p
(AD-A220340; SRL-0031-TR; DODA-AR-005-915) Avail: NTIS HC A03/MF A01 CSCL 04/2

This report investigates the applicability of the standard LOWTRAN atmospheric models to four typical Australian environments and considers the effects to these environments upon the transmission of 3 to 5 um radiation. It is found that the LOWTRAN model atmospheres can be useful in Australian conditions, and advice is given as to the most appropriate models to use depending upon the path and environment conditions. The extent to which model data is used rather than real data will affect the transmittance predictions; the magnitude of this effect is given, indicating that there is particular value in measuring water vapor content (shown to be the most significant meteorological parameter) in the lowest few kilometers through which the path passes. Transmittance as a function of range (and vice versa) is considered for all slant path angles from vertical to horizontal. Graphical results are presented in full as a resource to be consulted given a particular site ad path transmittance prediction requirement. GRA

**N90-23836#** National Weather Service, Honolulu, HI.
**TROPICAL CYCLONES, 1989: CENTRAL NORTH PACIFIC**
A. K. T. Chun, R. T. Martin, and H. E. Rosendal Feb. 1990 24 p
(PB90-182536; NOAA-TM-NWSTM-PR-35) Avail: NTIS HC A03/MF A01 CSCL 04B

Central north Pacific tropical cyclone data, 1989; tropical depression Four-E and Five-E; hurricane Dalilia; hurricane Dalilia (actual vs best track error); hurricane Dalilia (24 hour forecast verification); hurricane Dalilia (36 hour forecast verification); hurricane Dalilia (48 hour forecast verification); hurricane Dalilia (72 hour forecast verification); tropical depression Ismael; GOES-C visual imagery of tropical depression Ismael; and the 1989 forecast verification summary are presented. GRA

**N90-23837*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**NIMBUS-7 TOMS ANTARCTIC OZONE ATLAS: AUGUST THROUGH NOVEMBER, 1989**
Arlin J. Krueger, Lanning M. Penn, David E. Larko, Scott D. Doiron, and Patricia T. Guimaraes (ST Systems Corp., Vienna, VA.) Jul. 1990 176 p
(Contract NAS5-29373)
(NASA-RP-1237; NAS 1.61:1237; Rept-90B00114) Avail: NTIS HC A09/MF A01 CSCL 04B

Because of the great environmental significance of ozone and to support continuing research at the Antarctic and other Southern Hemisphere stations, the development of the 1989 ozone hole was monitored using data from the Nimbus-7 Total Ozone Mapping Spectrometer (TOMS) instrument, produced in near-real-time. This Atlas provides a complete set of daily polar orthographic projections of the TOMS total ozone measurements over the Southern Hemisphere for the period August 1 through November 30, 1989. The 1989 ozone hole developed in a manner similar to that of 1987, reaching a comparable depth in early October. This was in sharp contrast to the much weaker hole of 1988. The 1989 ozone hole remained at polar latitudes as it filled in November, in contrast to other recent years when the hole drifted to mid-latitudes before disappearing. Daily ozone values above selected Southern Hemisphere stations are presented, along with comparisons of the 1989 ozone distribution to that of other years. Author

**N90-23838** Oklahoma Univ., Norman.
**INITIATION AND PROPAGATION OF THUNDERSTORM MESOCYCLONES Ph.D. Thesis**
Rodger Alan Brown 1989 330 p
Avail: Univ. Microfilms Order No. DA8919983

Dual Doppler radar measurements were used to investigate the kinematics and radar reflectivity features of a developing supercell storm that occurred in south-central Oklahoma on 6 June 1979 during Project SESAME. Although the Agawam storm exhibited reflectivity characteristics typical of a supercell storm propagating continuously to the right of the mean wind, Doppler velocity measurements revealed discrete propagation through the formation of a series of right-flank updrafts. The appearance of continuous rightward propagation evidently was in response to the temporal and spatial integration of decreasing precipitation being produced by the dying updraft and increasing precipitation being produced by the new right-flank updraft. The commencement of rightward propagation was associated with the development of middle-altitude updraft rotation (organization stage of mesocyclone). Customarily, updraft rotation is thought to arise from the vertical tilting and stretching of streamwise horizontal vorticity. Though streamwise horizontal vorticity was present at low altitudes within the environment of the Agawam storm, it was found that updraft rotation resulted from an entirely different process - one that was initiated by the formation of a middle-altitude vorticity couplet on the left and right forward flanks on the updraft. The couplet apparently developed when a nonrotating updraft became strong enough to act as an obstacle to the middle-altitude environmental flow. Middle-altitude updraft rotation commenced when the first new right-flank updraft grew upward through the cyclonic member of the vorticity couplet, entraining and stretching the ambient vertical vorticity. Each new rotating updraft produced its own

vorticity couplet, which in turn was the source of vertical vorticity for the next updraft. Dissert. Abstr.

# 48 OCEANOGRAPHY

Includes biological, dynamic, and physical oceanography; and marine resources.

For related information see also *43 Earth Resources and Remote Sensing.*

**N90-23839#** Woods Hole Oceanographic Inst., MA.
**THE TRACE METAL GEOCHEMISTRY OF SUSPENDED OCEANIC PARTICULATE MATTER Ph.D. Thesis**
Robert M. Sherrell Aug. 1989 216 p Prepared in cooperation with Massachusetts Inst. of Technology, Cambridge
(Contract N00014-86-K-0325)
(AD-A218604; WHOI-89-27) Avail: NTIS HC A10/MF A02 CSCL 08/3

Vertical profiles of suspended particulate trace metals were measured in the Sargasso Sea near Bermuda and in the California Current, northwest Pacific. Using a new in situ pump, sufficiently large samples of particulate matter (order 10mg) were collected to allow measurement of a suite of trace metals as well as major component elements, using several different leaching techniques on separate subsamples. Concentrations of particulate copper, zinc, cobalt, cadmium, nickel, and lead near Bermuda were determined to be substantially lower than estimates based on previously published work. Concentrations of the more abundant elements Aluminum, Fe, and Mn were similar to previous estimates. Vertical profiles of Mn, Co, Pb, Zn, Cu, and Ni (mol/l) at Bermuda displayed similar features: a relative depletion in surface waters, a relative maximum in the upper thermocline, and relatively constant deep water concentrations. The similarity in the vertical variations of dissolved/particulate fractionation for these metals may be caused by interaction of dissolved metals with authigenic Mn phases; the fractionation is anti-correlated with other major particle components (organic carbon, calcium carbonate, opal, and aluminosilicate). The vertical profile of particulate Cd displayed a different form: enrichment at the surface and decreasing concentrations through the thermocline to constant deep water values. GRA

**N90-23840#** Woods Hole Oceanographic Inst., MA.
**MODELLING BOTTOM STRESS IN DEPTH-AVERAGED FLOWS Ph.D. Thesis**
Harry Leonard Jenter, II Sep. 1989 156 p Prepared in cooperation with Massachusetts Institute of Technology, Cambridge
(Contract N00014-86-K-0061)
(AD-A218605; WHOI-89-33) Avail: NTIS HC A08/MF A01 CSCL 08/3

The relationship between depth-averaged velocity and bottom stress for wind-driven flow in unstratified coastal waters is examined here. The adequacy of traditional linear and quadratic drag laws is addressed by comparison with a 2 1/2-D model. A 2 1/2-D model is one which a simplified 1-D depth-resolving model (DRM) is used to provide an estimate of the relationship between the flow and bottom stress at each grid point of a depth-averaged model (DAM). Bottom stress information is passed from the DRM to the DAM in the form of drag tensor with two components: one which scales the flow and one which rotates it. This eliminates the problem of traditional drag laws requiring the flow and bottom stress to be collinear. In addition, the drag tensor field is updated periodically so that the relationship between the velocity and bottom stress can be time-dependent. However, simplifications in the 2 1/2-D model that render it computationally efficient also impose restrictions on the time-scale of resolvable processes. Basically, they must be much longer than the vertical diffusion time scale. GRA

**N90-23841#** Woods Hole Oceanographic Inst., MA.
**EFFICIENT REPRESENTATION OF THE HYDROGRAPHIC STRUCTURE OF THE NORTH ATLANTIC OCEAN AND ASPECTS OF THE CIRCULATION FROM OBJECTIVE METHODS Ph.D. Thesis**
Ichiro Fukumori Jun. 1989 241 p Prepared in cooperation with Massachusetts Institute of Technology, Cambridge Sponsored in part by Navy
(Grant NSF OCE-85-21685)
(AD-A218606; WHOI-89-14) Avail: NTIS HC A11/MF A02 CSCL 08/3

This dissertation systemmatically studies mathematical techniques for determining ocean circulation from classical hydrographic data. The first aspect analyzed is finding an efficient representation of hydrographic structure to make it most useful and informative. The second is application of inverse methods to the data to determine ocean circulation. The efficient representation is examined in terms of empirical orthogonal functions (EOFs) among the variations in vertical hydrographic profiles. The data used are of a new set of high quality hydrography, all obtained in the early 1980s. Common EOFs are examined among temperature, salinity, oxygen, phosphate, silicate, and nitrate. The EOFs identify a fundamental simplicity in the spatial distributions of these properties. Although the volume of numbers involved in the raw data is large, the significant degrees of freedom are only six in space and two among the six properties; temperature and salinity are represented by one mode, while the nutrients by another. The modal structure reflects some underlying simplicity in ocean physics. Two applications of inverse methods are explored on small regional scales. The first problem addressed concerns the circulation inside a 12 deg square located in the eastern basin over the axis of the Mediterranean Water tongue. The study is based on an ocean model constructed by mapping the modes identified in the first half of the thesis over the entire North Atlantic Ocean. GRA

**N90-23842#** Woods Hole Oceanographic Inst., MA.
**TRACE METAL SOURCES FOR THE ATLANTIC INFLOW TO THE MEDITERRANEAN SEA Ph.D. Thesis**
Alexander F. M. J. VanGeen Jun. 1989 182 p Prepared in cooperation with Massachusetts Inst. of Technology, Cambridge
(Contract N00014-86-K-0325)
(AD-A218607; WHOI-89-17) Avail: NTIS HC A09/MF A01 CSCL 08/3

Copper, Cadmium and Zinc concentrations over a 40 km long portion of the Spanish continental shelf are an order of magnitude higher than enrichments generally found in coastal water. All samples were analyzed with a simple device which automates the pre-concentration of Cu, Nickel, Cd, Zn and from seawater and fresh water by bis (2-hydroxyethyl) - dithiocarbamate-metal complex retention on a hydrophobic column. Enrichments observed over the Spanish shelf are sufficient to influence the composition of the Mediterranean because Spanish coastal water is entrained in the inflow to the Alboran Sea. Trace metal and ancillary data for 172 samples from the Gulf of Cadiz collected in April and October '86 confirm that Spanish shelf water dominates Cu, Cd and Zn fluxes through the Strait of Gibraltar. A shelf metal-trap mechanism is presented in order to reconcile the magnitude of observed metal enrichments with their geographical distribution and seasonal variability. A simple box model of the metal-trap indicates this mechanism must be operating over the whole length of the Iberian Atlantic coast (rather than the Gulf of Cadiz only) in order to support the important metal sink through the Strait of Gibraltar. The three water masses originating in the Atlantic and entering the Alboran Sea through the Strait of Gibraltar are: (1) Atlantic surface water, (2) North Atlantic Central Water, and (3) Spanish shelf water, based on salinity and Cu, Ni, Cd and Zn concentrations. GRA

**N90-23843#** Rondout Associates, Inc., Stone Ridge, NY.
**ULF/VLF OCEAN BOTTOM SEISMO-ACOUSTICS Final Report, 1 Jul. 1986 - 1 Jan. 1990**

George H. Sutton 27 Feb. 1990 30 p
(Contract N00014-86-C-0570)
(AD-A218810) Avail: NTIS HC A03/MF A01 CSCL 08/3

The original research under this contract was directed toward comparison of ocean bottom seismometer and hydrophone data with ocean sub-bottom seismometer data and with appropriate synthetics to determine the effect of sub-bottom structure on the signals received; expected propagation loss; predominant modes of propagation; instrument signal distortion and excess noise; expected spacial coherence; and expected improvement from polarization and array processing. During the first and subsequent years of the contract, research emphasis was re-directed toward analysis interpretation of data from the Columbia-Point Arena ocean bottom seismic station (OBSS) emphasizing the objectives of the ONR Accelerated Research Initiative in ULF/VLF Ocean Seismo-Acoustics. GRA

**N90-23844#** Naval Postgraduate School, Monterey, CA.
**KINEMATICS UNDER WIND WAVES M.S. Thesis**
Manuel P. Abreu Sep. 1989 83 p
(AD-A219541) Avail: NTIS HC A05/MF A01 CSCL 08/3

The ocean near surface kinematics were measured as part of the SAXON experiment. A wide range of wind forcing and wave conditions occurred during the measurement period. Two orthogonal components of the horizontal velocity were measured using an electromagnetic current meter. The wave directional field was measured using a high resolution 2 meter square slope array. The classical Longuet-Higgins et al (1963) method of computing directional wave spectra and the new exact Fourier coefficients representation method (Grauzinis, 1989) are used to compute directional wave spectra. The new method of computing directional wave spectra, which represents bi-modal distributions of wave energy exactly matching the measured Fourier coefficients to second order, demonstrated improved performance over the classical technique. Phase functions between the sea surface elevation and horizontal velocity components compared well with the results predicted by linear wave theory. The coherence function of the horizontal velocity components and the sea surface elevation confirmed the dependence on the wave field directivity. Spectra of the sea surface elevation computed from pressure and horizontal velocity data compared well using linear theory transfer functions. GRA

**N90-23845#** Naval Postgraduate School, Monterey, CA. Dept. of Oceanography.
**TEST AND EVALUATION OF SURF FORECASTING MODEL M.S. Thesis**
Nasuh Cacina Sep. 1989 50 p Sponsored by Naval Environmental Prediction Research Facility, Monterey, CA and ONR
(AD-A219580) Avail: NTIS HC A03/MF A01 CSCL 08/3

A model forecasting wave height and longshore current distribution inside the surf zone is applied to an extensive set of laboratory and field data for testing and modification. The models are tested on planar beaches as well as barred beaches for a variety of wave conditions. The wave transformation model is based on solving the energy flux equation using a bore dissipation mechanism and describing the random wave heights with the Rayleigh distribution. The two model parameters, B and gamma, where B describes the amount of foam of a breaking wave and gamma is the proportionality constant which relates the rms wave height to the water depth, are combined into a single parameter BG. BG is shown to be a function of deep water surf similarity parameter. Applied to the present data sets, the rms error of the measured wave height and the model predicted wave height was usually less than 9 percent and ranged from 1.5 to 15.7 percent with a mean of 5.3 percent and a standard deviation of 3.1 percent for the whole 74 data sets. The wave transformation model is highly robust in describing the wave height distribution in the surf zone. The longshore current model is based on solving the steady state, alongshore momentum balance for straight and parallel contours using the radiation stress concept. The model requires specifying the bed shear stress and turbulent mixing coefficients. Applied to the present data sets the rms error between the measured and modeled longshore current values ranged from 4.5 to 55.5 percent with a mean of 5.3 percent and a standard deviation of 3.1 percent for the whole 74 data sets. GRA

**N90-23846#** Naval Postgraduate School, Monterey, CA. Dept. of Oceanography.
**MODELING STUDIES OF THE LEEUWIN CURRENT USING A HIGH-RESOLUTION PRIMITIVE EQUATION MODEL M.S. Thesis**
Martin J. Rutherford Sep. 1989 204 p Sponsored by NSF, Washington, DC
(AD-A219595; NPS68-89-010) Avail: NTIS HC A10/MF A02 CSCL 08/3

A primitive equation model is run to investigate generation and instability mechanisms in the Leeuwin Current. The current is generated by the model using a combination of density forcing from the climatological Indian Ocean thermal structure, the influx of warm low salinity water from the North West (NW) Shelf, and the climatological wind stress. The current thus generated is compared with observations taken during the LeeUwin Current Interdisciplinary Experiment (LUCIE). In the absence of the NW Shelf water, which corresponds to the austral spring and summer flow, wind forcing is dominant at the equatorward end of the domain and geostrophic flow, driven by the Indian Ocean thermal gradient dominates at the poleward end. This leads to a weak coastal upwelling regime with equatorward and offshore flow at the equatorward end. Further poleward, the stronger Indian Ocean forcing establishes a poleward surface current and equatorward undercurrent which accelerates poleward, into the prevailing wind. The inclusion of NW Shelf waters, typical of the austral fall and winter seasons, completely dominates the wind forcing at the equatorward end of the model. GRA

**N90-23847#** Naval Postgraduate School, Monterey, CA. Dept. of Oceanography.
**A NUMERICAL STUDY OF WIND FORCING IN THE EASTERN BOUNDARY CURRENT SYSTEM OFF PORTUGAL M.S. Thesis**
Carlos N. LopesdaCosta Sep. 1989 128 p Sponsored by ONR, Arlington, VA
(AD-A219596; NPS68-89-007) Avail: NTIS HC A07/MF A01 CSCL 04/2

A high resolution, multi-level, primitive equation ocean model is used to examine the response to wind forcing of an idealized, flat-bottomed oceanic regime on a beta-plane, along the eastern ocean boundary off the west coast of the Iberian Peninsula. Three experiments are conducted to investigate the role of different types of prescribed wind forcing. In experiment 1, a band equatorward winds which are uniform alongshore but contain zonal variability (i.e., large negative wind stress curl near the coast), results in an equatorward coastal surface current nearshore and a poleward surface current offshore. With time, the currents become unstable and anticyclonic warm core eddies develop in the region of negative wind stress curl. In experiment 2, the model is forced with poleward wind stress for 20 days followed by a sudden change to equatorward wind stress. A 1-2 day transition from downwelling and a poleward surface current near the coast to upwelling and an equatorward surface jet occurs. With the time the upwelled isotherms are displaced offshore, the equatorward surface jet widens and gets shallower nearshore, and the poleward undercurrent moves closer to the surface (depth approx. = 120 m at the coast). For experiment 3, a time series of 6-hourly values of the north/south component of the wind, computed from Fleet Numerical Oceanography Center synoptic surface pressure analyses are used to investigate the response of the coastal current system to time dependent wind forcing. GRA

**N90-23848#** Naval Postgraduate School, Monterey, CA. Dept. of Oceanography.
**DETERMINATION OF TIDE HEIGHTS FROM AIRBORNE BATHYMETRIC DATA M.S. Thesis**
Kenneth E. Welker Dec. 1989 107 p
(AD-A220412) Avail: NTIS HC A06/MF A01 CSCL 08/3

Airborne bathymetric systems are currently under development. When fully developed, the NAVOCEANO plans to use this survey technology. NAVOCEANO faces a unique problem in using airborne bathymetry, in that it plans to survey in remote and undeveloped areas of the world where tide control obtained through tide gauge deployment is often logistically and economically prohibitive. This thesis offers a method for significantly reducing the number of tide gauges needed for tide control in such a survey when the survey is conducted in an open coast environment. The approach provides a method for delineating a tidal zone and then suggests a survey scenario which will allow the isolation of the major components of the tidal signal through a least squares adjustment. A proof of concept simulation model developed in the thesis results in tidal depth reducers which more than satisfy IHO specifications. GRA

**N90-23849#** Hawaii Univ., Manoa. Inst. of Geophysics.
**SEISMIC ANISOTROPY AND LARGE-SCALE POROSITY IN THE OCEAN FLOOR Final Technical Report, 1 Jan. - 31 Dec. 1989**
Gerard J. Fryer 31 Dec. 1989 47 p
(Contract N00014-89-J-1483)
(AD-A220453) Avail: NTIS HC A03/MF A01 CSCL 08/3

Conventional marine seismic studies assume an isotropic velocity structure for marine sediments. Yet marine sediment cores routinely show anisotropy (Bachman 1979, 1983; Carlson, Schaftenaar and Moore 1984). Although highly anisotropic minerals such as calcite make up typical sediments, within each sedimentary microlayer these minerals orient randomly, making individual microlayers isotropic. Anisotropy of marine sediments results primarily from bedding, the interleaving of thin isotropic layers (Carlson et al. 1984). Any medium composed of different isotropic layers that are much thinner than a seismic wavelength is anisotropic. This lamellate medium will exhibit transverse isotropy with an axis of symmetry orthogonal to the layering (Postma 1955; Backus 1962). To completely describe the compressional and shear wave velocities of seismic waves travelling in an arbitrary direction through a transversely isotropic (TI) medium, five independent elastic parameters are required (Love 1920). Determining all five parameters necessitates recording compressional waves, and shear waves in two directions. Conventional marine seismic experiments may detect indications of anisotropy, such as mismatches between models derived from reflection and refraction studies (Davis and Clowes 1986) or discrepancies between seismic models and drill hole data (Banik 1984). But quantifying the anisotropy completely (i.e., determining all five parameters) is impossible unless unconverted shear waves are recorded. GRA

**N90-23850#** Technische Univ., Delft (Netherlands).
**PREDICTING TIDAL DISPLACEMENTS OF THE SURFACE OF THE EARTH, VOLUME 1 Thesis**
B. J. R. Janssen Aug. 1989 56 p
(ETN-90-96690) Avail: NTIS HC A04/MF A01

Tidal deformations are of increasing importance to geodesy (VLBI, satellite geodesy). A FORTRAN program to predict the tidal displacements is adapted for use on a personal computer. The direct, or body tides are computed using the potential developments of Cartwright, Tayler and Edden. A set of Love-numbers that can easily be modified is applied. The indirect effects due to ocean loading are computed by means of a larger scale computer since it involves a convolution over the world's ocean. Cotidal charts by Schwidersky, divided into 1 by 1 degree squares is used. Some displacements (vertical, east-west and north-south) are plotted along with some derived results such as the ratio direct-indirect displacements and the dilatation of baselines. ESA

**N90-23851#** Technische Univ., Delft (Netherlands).
**PREDICTING TIDAL DISPLACEMENTS OF THE SURFACE OF THE EARTH, VOLUME 2 Thesis**
B. J. R. Janssen Aug. 1989 49 p
(ETN-90-96691) Avail: NTIS HC A03/MF A01

Tidal deformations are of increasing importance to geodesy (VLBI, satellite geodesy). A FORTRAN program to predict the tidal displacements is adapted for use on a personal computer. The direct, or body tides are computed using the potential development of Cartwright, Tayler and Edden. A set of Love-numbers that can easily be modified is applied. The indirect effects due to the ocean loading are computed by means of a larger scale computer since it involves a convolution over the world's ocean. Cotidal charts by Schwidersky, divided into 1 by 1 degree squares is used. Some displacements (vertical, east-west and north-south) are plotted along with some derived results such as the ratio direct-indirect displacements and the dilatation of baseline. Volume 2 contains a description of the program and various subroutines. ESA

**N90-23852#** Technische Univ., Delft (Netherlands). Faculty of Geodesy.
**OCEAN VARIABILITY FROM CROSSOVER DIFFERENCES DERIVED FROM ALTIMETER MEASUREMENTS**
R. C. V. Feron Jun. 1989 85 p
(ETN-90-96695) Avail: NTIS HC A05/MF A01

The processing of SEASAT altimeter data in order to extract an oceanographic signal is described. Original SEASAT altimeter data was used to apply a crossover adjustment in the south African ocean region. Comparison with another technique to derive temporal variability from SEASAT observations showed agreement. The sea level time series supplies a new oceanographic signal. Time varying oceanographic effects like eddie-movements and sea surfaces accelerations were observed during the time the altimeter was operational. These last two results indicate possibilities for the use of altimetry in oceanography. ESA

**N90-23853#** Groningen Rijksuniv. (Netherlands). Dept. of Mathematics.
**CONSIDERATIONS CONCERNING THE DETERMINATION OF THE MOST DESIRABLE HEIGHT FOR SEA DIKES [OVERWEGINGEN BIJ HET BEPALEN VAN DE MEEST WENSELIJKE HOOGTE VAN DE ZEEDIJKEN]**
D. W. Brand Aug. 1989 45 p In DUTCH
(W-8905; ETN-90-96715) Avail: NTIS HC A03/MF A01

The problem of the choice of a strategy to determine the annual investments for sea dikes heightening is discussed with a view to guaranteeing the security and increasing the amount of protected land. Several scenarios to solve the problem, and an algorithm for numerical calculations are presented. Some statistical considerations are given. Examples show that differences can occur between the different scenarios due to changes in the values of the parameters. The choice of the parameters can strongly affect the choice of a strategy. ESA

**N90-23854#** Beleidscommissie Remote Sensing, Delft (Netherlands).
**SEA BOTTOM TOPOGRAPHY WITH X-BAND SLAR Final Report**
J. Vogelzang, G. J. Wensink, G. P. deLoor, H. C. Peters, H. Pouwels, and W. A. vanGein (Royal Netherlands Navy, The Hague.) Oct. 1989 89 p
(BCRS-89-25; ETN-90-96765) Avail: NTIS HC A05/MF A01

The results of the investigations on the sea bottom topography are reported. The aim of this project is to investigate the usability of imaging bottom topography with side looking airborne radar and synthetic aperture radar for cartographic purposes, to establish the possibilities of this method in terms of mapping accuracy and geometrical resolution and to establish the optimum hydro-meteorological conditions. The most important conclusions from this study are the following: the extremes in the radar backscatter are located above regions with maximum bottom slope for X-band at a wind speed between 7.3 and 8.3m/s (5 Bft); and the optimum wind speed depends on the sensitivity of the radar system being used. ESA

**N90-23855#** Naval Postgraduate School, Monterey, CA.
**THE EFFECTS OF CLIMATOLOGICAL AND TRANSIENT WIND FORCING ON EDDY GENERATION IN THE CALIFORNIA CURRENT SYSTEM M.S. Thesis**

Robert W. Edson Sep. 1989 154 p
(AD-A219858; NPS68-89-008) Avail: NTIS HC A08/MF A01 CSCL 08/3

A high-resolution, multi-level, primitive equation ocean model is used to examine the response to transient and climatological wind forcing of an idealized, flat-bottomed oceanic regime on a beta-plane, along an eastern boundary. An annually periodic wind forcing function with zonal variability is used as transient forcing in several experiments using both winter and summer initializations. When the curl component of the forcing is stronger than the stress, as in the wintertime, a surface poleward flow develops in the nearshore region with an equatorward flow offshore. When wind stress dominates the forcing, as in the summertime, a coastal jet develops with an undercurrent. In other experiments, spatially varying one degree and two tenths degree steady wind stress data are used as climatological forcing. The one degree climatological wind stress data has positive curl at the coast which causes a poleward surface flow to develop. When two tenths degree wind stress data is used in the nearshore area, both positive and negative curl in the coastal region result in the formation of poleward and equatorward currents, respectively. As a result of convergence in the surface flow, eddies and a well-defined cold filament develop. These results show that the interaction of diverse coastal currents driven by an equally diverse wind field can play an important role in the production of cold filaments and eddies. GRA

**N90-23856#** Scripps Institution of Oceanography, La Jolla, CA. Marine Physical Lab.
**VERTICAL DIRECTIONALITY MEASUREMENTS OF AMBIENT NOISE IN THE NE PACIFIC**
B. J. Sotirin and W. S. Hodgkiss Aug. 1989 180 p
(Contracts N00014-87-C-0127; N00014-87-K-0225)
(AD-A220007; MPL-TM-412; MPL-U-46/89) Avail: NTIS HC A09/MF A01 CSCL 20/1

Vertical directionality measurements of the ambient noise field between 15 and 130 Hz are presented. These data were measured by a large aperture array deployed vertically from R/P FLIP at 35 deg N, 126 deg W in 4700 m of water. Spatial distribution is plotted as a function of frequency during specified times and as a function of time as specified frequencies during the onset of a local storm. Spectral levels of beams dominated by local noise sources display a threshold type behavior as wind speed increases. Spectral levels of beams dominated by distant shipping reveal the fine-scale structure of the ambient noise pedestal. Spatial distribution is also plotted as a function of depth at specified frequencies and wind speeds, although due to the temporal variability of the noise, no significant differences were seen with depth. GRA

**N90-23857#** Scripps Institution of Oceanography, La Jolla, CA. Marine Physical Lab.
**IN SITU INVESTIGATION OF SEA SURFACE NOISE FROM A DEPTH OF ONE METER Ph.D. Thesis**
Garr Edward Updegraff Dec. 1989 220 p
(Contract N00014-87-K-0010)
(AD-A220158; MPL-U-78/89; SIO-REF-89-21) Avail: NTIS HC A10/MF A02 CSCL 20/1

The mechanism responsible for audible underwater surface noise, particularly at low wind speeds, is not well understood. Because most surface noise recording instruments are deployed at depths of tens to thousands of meters, they can only characterize the behavior of a population of noise sources, rather than individual noise mechanisms. For this reason, an instrument was built and deployed at a depth of 1 meter to record the sounds and images of the sea surface during light winds. This self-suspending instrument contains an upward looking video camera, four hydrophones digitized at 20 kHz each, and positional sensors. A surface buoy, tethered 30 meters from the submerged instrument, continuously supplies the wind speed and direction. Recordings from the instrument indicate that surface noise produced during light winds is generated by small wavelet spills which have no correlation with the amplitude or phase of long period swells moving faster than prevailing winds. The averaged acoustic spectra from a single energetic spill showed a slope of -5 dB per octave, matching the spectral slope first reported by Knudsen, Alford, and Emling in 1948 for wind generated surface noise. GRA

**N90-23858#** Scripps Institution of Oceanography, La Jolla, CA. Marine Physical Lab.
**OBSERVATIONS OF SEAFLOOR AMBIENT NOISE WITH AN OCEAN BOTTOM SEISMOMETER ARRAY Ph.D. Thesis**
Anthony Edward Schreiner Dec. 1989 147 p Original contains color illustrations
(Contract N00014-87-K-0010)
(AD-A220159; MPL-U-84/89; SIO-REF-89-27) Avail: NTIS HC A07/MF A01 CSCL 20/1

In 1987 an array of ocean bottom seismometers (OBS) was deployed in the deep ocean off southern California for the purpose of recording ocean bottom ambient noise. By lowering the instruments with a wire, it was possible for the first time to create an array which allowed coherent processing of short wavelength energy in the frequency range 0.05 to 30 Hz. The array consisted of 9 working instruments in place for 30 days, allowing for the recording of ambient noise during several changes in the surface environment. Sea surface conditions were determined from the U.S. Navy's Global Spectral Ocean Wave Model (GSOWM). Noise levels at the ocean floor have been correlated with the swell height and wind speed predicted by the GSOWM. However, the theoretical transfer function between surface wave height and pressure fluctuations on the bottom did not predict the recorded pressure signal to a high degree of accuracy. The array achieved a uniform sampling of distances between sensors, and a good estimate of spatial coherence has been made up to 156 m. A characteristic pattern of coherence length dependence on frequency is observed throughout the deployment. Through modeling of seismic energy it has been possible to estimate the range to the source of the noise energy. The wavenumber decomposition or beamforming of the ambient noise presented some difficulties. GRA

**N90-23859#** Scripps Institution of Oceanography, La Jolla, CA. Marine Physical Lab.
**LARGE APERTURE ARRAY MEASUREMENTS OF THE VERTICAL AMBIENT NOISE FIELD**
B. J. Sotirin and W. S. Hodgkiss Jul. 1989 45 p
(Contracts N00014-87-K-0225; N00014-87-C-0127)
(AD-A220165; MPL-U-26/89; MPL-TM-411) Avail: NTIS HC A03/MF A01 CSCL 20/1

Use of a large aperture vertical array allows investigation into the fine-scale structure of the directional ambient noise field. Frequency and directional spectral estimates are calculated during the passage of a local storm, providing a detailed study of ambient noise levels at low frequencies as wind speed increases from 2 m/s to 12 m/s over a 21 hour period. Spectral levels of horizontal beams reflect distant sources. Spectral levels of beams directed toward the surface and the bottom display a threshold type behavior, suggesting the abrupt onset of a source mechanism such as breaking waves. Subsequent thresholds may indicate a change in source mechanism such as the conversion from spilling breakers to plunging breakers. GRA

**N90-23860#** Scripps Institution of Oceanography, La Jolla, CA. Marine Physical Lab.
**NAVIGATION SOFTWARE FOR THE MPL VERTICAL LINE ARRAY**
B. J. Sotirin and W. S. Hodgkiss Mar. 1989 103 p
(Contracts N00014-87-K-0225; N00014-87-C-0127)
(AD-A220166; MPL-U-12/89; MPL-TM-409) Avail: NTIS HC A06/MF A01 CSCL 17/7

This report describes the navigation software and demonstrates its operation using data obtained during an experiment in which a large aperture low frequency acoustic array, designed and built at the Marine Physical Laboratory (MPL), was deployed vertically from the Research Platform FLIP in the NE Pacific. The array was equipped with a 12 KHz acoustic navigation subsystem. Travel

time measurements from near bottom acoustic transponders of known position were received by specific array elements throughout the deployment. These measurements were converted to spatial positions of the array elements by a nonlinear least squares technique. The data collection methods and navigation software programs which locate the transponders, calculate the travel time from detected returns and convert travel times to spatial positions are documented. GRA

# 51 LIFE SCIENCES (GENERAL)

**N90-23861*#** National Aeronautics and Space Administration, Washington, DC. Div. of Life Sciences.
**STRATEGIC IMPLEMENTATION PLAN**
Apr. 1989 46 p
(NASA-TM-102907; NAS 1.15:102907) Avail: NTIS HC A03/MF A01 CSCL 06C

The Life Science Division of the NASA Office of Space Science and Applications (OSSA) describes its plans for assuring the health, safety, and productivity of astronauts in space, and its plans for acquiring further fundamental scientific knowledge concerning space life sciences. This strategic implementation plan details OSSA's goals, objectives, and planned initiatives. The following areas of interest are identified: operational medicine; biomedical research; space biology; exobiology; biospheric research; controlled ecological life support; flight programs and advance technology development; the life sciences educational program; and earth benefits from space life sciences. J.P.S.

**N90-23862#** Naval Aerospace Medical Research Lab., Pensacola, FL.
**EFFECTS OF CHOLINERGIC DRUGS ON EXERCISE PERFORMANCE AND SIMPLE REACTION TIME OF RHESUS MONKEYS Interim Report, Sep. 1985 - Sep. 1986**
John A. DAndrea, James C. Knepton, and J. O. deLorge 20 Nov. 1989 26 p
(AD-A219455; NAMRL-1349) Avail: NTIS HC A03/MF A01 CSCL 06/15

Four juvenile rhesus monkeys were trained to perform an exercise response and respond aperiodically to a visual signal. The exercise response simulated a rowing motion and typically resulted in heart rates in excess of 200 beats per minute. A red signal light was usually displayed during the exercise period. Using a partial reinforcement schedule, the red light was replaced aperiodically with a green signal light that indicated a reaction-time condition. Responses on a lever within 1 s of the green light onset resulted in a food pellet. The drugs atropine sulfate, pralidoxime chloride, pyridostigmine bromide, scopolamine hydrobromide, and meclizine hydrochloride were administered concurrently or individually before the exercise session. Atropine sulfate and pralidoxime hydrochloride were administered in three dose levels. The current drug administration produced significant dose-related decrements in exercise responses and increases in postreinforcement pause times. Tail temperatures during drug testing generally were below baseline temperatures. Only atropine sulfate, when tested individually, produced behavioral effects. Neither concurrent nor individual administration of the drugs produced any reaction-time change. The availability of tapwater during training and drug testing sessions did not alter atropine sulfate effects on performance. GRA

**N90-23863#** Naval Aerospace Medical Research Lab., Pensacola, FL.
**HIGH PEAK POWER MICROWAVE PULSES AT 2.37 GHz: NO EFFECTS ON VIGILANCE PERFORMANCE IN MONKEYS Interim Report, Feb. 1988 - Feb. 1989**
John A. DAndrea, James C. Knepton, B. L. Cobb, B. Jon Klauenberg, J. H. Merritt, and David N. Erwin 2 Nov. 1989 19 p Prepared in cooperation with School of Aerospace Medicine, Brooks AFB, TX
(AF Proj. 7757)
(AD-A219570; NAMRL-1348; USAFSAM-TR-89-21) Avail: NTIS HC A03/MF A01 CSCL 20/14

The current safety standards for occupational exposure radio frequency and microwave exposure do not limit the peak power of microwave pulses. To evaluate whether short-duration (93 ns) high-peak-power microwave pulses can alter behavioral performance, four rhesus monkeys were exposed to peak powers of 7.02 to 11.30 kW/cm2 while they performed a vigilance task. The behavior consisted of two components: responding on a variable interval schedule on one lever and to reaction time on a second lever. Correct responding on each lever was signaled by auditory stimuli. Trained monkeys performed the task during exposure to 2.37-GHz microwave pulses delivered concurrently with the auditory signals. The estimated peak whole-body specific absorption rate (SAR) for each pulse was between 582.7 and 937.9 kW/kg (54 to 87 mJ/kg per pulse). Compared to sham irradiation, significant changes in behavioral performance were not observed. GRA

**N90-23864#** Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany, F.R.). Central Labs.
**BIOSENSORS FOR THE DETECTION OF HEAVY METAL IONS**
R. Hilpert, F. Binder, and M. H. Zenk (Technische Univ., Munich, Germany, F.R. ) 1989 12 p
(MBB-Z-0289-89-Pub; ETN-90-96778) Avail: NTIS HC A03/MF A01

Phytochelatins, metallothioneins and glutathione are under investigation as biological components for the development of biosensors for heavy metal ion detection in aqueous solutions. These peptides/proteins selectively bind heavy metal ions by thiolate complex formation. If the biological component is immobilized on the surface of an appropriate transducer, changes within the layer of immobilized peptides/proteins (e.g., release of protons, changes of mass and optical properties), effected by binding of metal ions, may be transformed into electrical signals by the transducer (proton-sensitive field effect transistor, mass-sensitive piezoelectric crystal or optical device). Preliminary experiments are made which demonstrate the suitability of phytochelatins and glutathione as biological components for the development of biosensors for heavy metal. ESA

# 52 AEROSPACE MEDICINE

Includes physiological factors; biological effects of radiation; and effects of weightlessness on man and animals.

**N90-23865#** Army Research Inst. of Environmental Medicine, Natick, MA. Exercise Physiology Div.
**PHYSIOLOGICAL AND PERCEPTUAL RESPONSES TO PROLONGED TREADMILL LOAD CARRIAGE Final Report, May 1988 - Nov. 1989**
John F. Patton, John Kaszuba, Robert P. Mello, and Katy L. Reynolds Feb. 1990 45 p
(DA Proj. 3E1-62787-A-879)
(AD-A218809; USARIEM-T11-90) Avail: NTIS HC A03/MF A01 CSCL 06/10

The objectives were to: determine the physiological and perceptual responses to prolonged, level treadmill walking (fixed distance of 12 km) at speeds of 3.96, 4.86, and 5.76 km/hr, unloaded (clothing wt of 5.2 kg) and with external loads (load carriage equipment + backpack) of 31.5 and 49.4 kg; determine the ability of subjects to perform high intensity, anaerobic exercise (Wingate test) immediately after load carriage; and compare the energy cost and perceptual responses of carrying the standard external frame pack to that of the new internal system. Fifteen male subjects performed nine load carriage trials with an external frame pack (ALICE) and two trials with an internal frame pack (IIFS) in random order over a 7 week period. The results show that: energy cost during prolonged load-carriage is not constant but increases significantly over time at relative intensities below 30 percent VO2max; the load-carriage conditions were not sufficient

to cause fatigue as assessed by blood lactate levels and maximal power outputs; and the two load-carriage systems studied did not differ as to their effects on physiological an perceptual responses to prolonged treadmill walking. GRA

**N90-23866#** Navy Experimental Diving Unit, Panama City, FL.
**FIELD MANAGEMENT OF ACCIDENTAL HYPOTHERMIA DURING DIVING Final Report**
John A. Sterba Jan. 1990 29 p
(AD-A219560; NEDU-1-90) Avail: NTIS HC A03/MF A01 CSCL 06/10

Hypothermia of both the extremities and the body core continues to be a major problem in cold water diving. Presently, extremity hypothermia of the hands limits cold water diving exposure more so than body core hypothermia. Painful or numb fingers decrease dexterity, safety, work capacity, and increase the risk of developing nonfreezing cold injury (NFCI), which is reviewed. Levels of body core hypothermia, based on rectal core temperature, are mild (35 to 32), moderate (32 to 28), and severe hypothermia (below 28 C). As it relates to cold water diving, the pathophysiology of immersion and mild to severe hypothermia is reviewed including thermoregulation and effects on organ systems. The diving response, composed of bradycardia and peripheral vasoconstriction, has been shown in man to not prolong breath-holding time, or influence alveolar gas exchange, such as oxygen consumption. Survival from cold water near-drowning may be more dependent on hypothermia than previously recognized. The predisposing factors leading to hypothermia during diving operations are discussed. The determination of body core temperature from various sites including new radio pill telemetry is reviewed. The levels of hypothermia by physical exam findings are reviewed in detail. The field treatment of hypothermia is discussed with attention to a review of the literature, recent research, and first aid management guidelines. The prevention of hypothermia during diving operations and current diving medicine research in the active thermal protection of free swimming divers is reviewed. GRA

**N90-23867#** Indiana Univ., Bloomington. Hearing and Communication Lab.
**PERCEPTION OF COMPLEX AUDITORY PATTERNS Final Report, 1 Sep. 1987 - 30 Sep. 1989**
Charles S. Watson and Gary R. Kidd Nov. 1989 21 p
(Grant AF-AFOSR-0300-87; AF Proj. 2313)
(AD-A219626; AFOSR-90-0301TR) Avail: NTIS HC A02/MF A01 CSCL 06/4

The results of research are discribed in four areas: the perception of complex sounds, including tonal sequences, multidimensional complex sounds, and Gaussian noise; information integration; multi-stage decision making; and studies of the relation between auditory abilities measured with speech and nonspeech stimuli. Major accomplishments during this funding period include: the discovery of the proportion-of-the-total-duration (PTD) principle: Each individual component of a complex sound is resolved with an accuracy that is a function of its proportion of the total duration of the sound; even small degrees of logarithmic frequency transposition of tonal patterns severely degrades the detectability of pattern changes in novel sequences, but not in familiar sequences; temporal integration of auditory information is limited by two distinct types of internal noise, one that is added at the periphery before a decision statistic is formed, and 'central', or post-decision, noise; the development of a theory that incorporates these limiting factors; and the completion and publication of studies of categorical perception for speech and non-speech sounds, demonstrating that enhanced discrimination performance in the region of certain categorical boundaries does not reflect either hard-wired feature detectors in the auditory nervous system, nor psychoacoustic boundaries determined by acoustic peculiarities of complex waveforms. GRA

**N90-23868#** School of Aerospace Medicine, Brooks AFB, TX. Radiation Sciences Div.
**MODEL FOR PREDICTING THE EFFECTS OF LASER EXPOSURES AND EYE PROTECTION ON VISION Interim Report, Jan. 1989 - Jan. 1990**
Arthur R. Menendez and Peter A. Smith (Royal Air Force Inst. of Aviation Medicine, Farnborough, England ) Jan. 1990 14 p
(AF Proj. 7757)
(AD-A219697; USAFSAM-PROC-89-26) Avail: NTIS HC A03/MF A01 CSCL 06/10

Laser safety standards and eye protection (filters) are designed to limit ocular exposures to prevent retinal lesions, yet eyesafe laser exposures can disrupt vision by causing glare and flashblindness. Protective filters can have opposing effects on vision function. The protective filters reduce laser exposures but also reduce task luminance and contrast. Filters alone may interfere with vision and consequently reduce work safety and performance. It is therefore important to be able to predict the effects of both laser exposures and protective filters to assess trade-offs between protection and visual function. This paper briefly reviews the methods, concepts, and experimental database used in the laboratory to predict laser, filter, and laser-plus-filter effects on tasks involving visual detection. The modeling approach uses estimates of the spatial distribution of light in the retinal image of the laser source to predict glare, flashblindness, and retinal lesions. It also considers the non-uniformity of visual abilities across the retina in predicting the impact of a laser exposure of a given size and retinal location. The proposed modeling approach provides a general framework for the interpretation, integration, and application of data from various studies. It has the potential to assess the effects of lasers and eye-protection devices on vision, and to guide visual simulations of the appearance of displays and scenes after laser exposures. GRA

**N90-23869#** Wisconsin Univ., Madison. Dept. of Preventive Medicine.
**EFFECTS OF HIGH ALTITUDE HYPOXIA ON LUNG AND CHEST WALL FUNCTION DURING EXERCISE Midterm Report, 30 Jun. 1988 - 30 Dec. 1989**
Jerome A. Dempsey 27 Jan. 1990 9 p
(Contract DAMD17-88-C-8053; DA Proj. 3M1-62787-A-879)
(AD-A219814) Avail: NTIS HC A02/MF A01 CSCL 06/10

The mechanical limitations to normal exercise in healthy persons was defined more precisely than ever before. In most instances in the normal or moderately fit individual, the ventilatory requirement is such that mechanical limitations are barely reached on expiration but not to inspiratory muscles in heavy exercise and fatigue of respiratory muscles is not a factor. The greater the level of physical fitness, the greater the maximum exercise load the greater the probability that mechanical limitation to flow on expiration and to pressure generation by inspiratory muscles on inspiration will be achieved over a substantial part of the tidal breath. This results in an even higher oxygen cost of respiration in these subjects that reach mechanical limitation. On the other hand, it is only in very rare instances that we observed that this mechanical limitation interfered with the provision of sufficient alvelor hyperventilation in these subjects to achieve adequate gas exchange and arterial oxygenation and acid-base regulation. GRA

**N90-23870#** Army Aeromedical Research Lab., Fort Rucker, AL. Biodynamics Research Div.
**EVALUATION OF THE HEAD INJURY HAZARD DURING MILITARY PARACHUTING Final Report**
Charles R. Paschal, Jr., Ronald W. Palmer, Dennis F. Shanahan, and Joseph L. Haley, Jr. Mar. 1990 53 p
(DA Proj. 3E1-62787-A8-78)
(AD-A220724; USAARL-90-6) Avail: NTIS HC A04/MF A01 CSCL 01/2

The incidence of head injury during U.S. Army airborne training and airborne operations has doubled in recent years. A number of factors are known to contribute to head injuries incurred during airborne training/operations. These factors include the small

amount of impact protection provided by the Personal Armor System for Ground Troops (PASGT) helmet, shortcomings in training procedures, and failure of trained airborne troops to follow proper procedures when jumping. Other factors are involved as well. This report shows, with relatively little modification, the impact protection and retention characteristics of the PASGT airborne helmet can be significantly improved. Also, this report evaluates a number of factors present in airborne training and operational environments that contribute to head injury and explains how training and operational procedures can be modified to reduce the incidence of repeated headstrikes and subsequent serious head injuries. GRA

**N90-23871#** North Dakota State Univ., Fargo. Dept. of Electrical and Electronics Engineering.
**DURIP-INSTRUMENTATION FOR RECORDING AND ANALYZING MULTIPLE INPUT/OUTPUT SACCADIC EYE MOVEMENT NEUROSENSORY CONTROL Final Technical Report, 1 Dec. 1988 - 30 Nov. 1989**
John Enderle 29 Jan. 1990 19 p
(Grant AF-AFOSR-0092-89; AF Proj. 3842)
(AD-A219905; AFOSR-90-0342TR) Avail: NTIS HC A03/MF A01 CSCL 06/4

To investigate multiple input-multiple output saccadic eye movement neurosensory control, both three-dimensional eye movement data are recorded and analyzed. The purpose of this grant is funding computer equipment for analysis of head and saccadic eye movement data, to describe the neurosensory control mechanism response from combined visual, auditory and vestibular stimuli during enhancement and inhibitory modes. The ultimate goal is to enhance the understanding of how the brain integrates and controls neurosensory information. Data analysis is carried out in both the time and frequency domain. The system identification technique is used for parameter and control estimation from the data collected. Significant advances on eye rectus muscle model development and a neural network for saccades have been made. It should be noted that the use of the equipment purchased with this grant will continue in the future. GRA

**N90-23872#** Central Inst. for the Deaf, Saint Louis, MO.
**AUDITORY PERCEPTION OF COMPLEX SOUNDS Final Report, 1 Sep. 1987 - 31 Dec. 1989**
Ira J. Hirsh 6 Mar. 1990 3 p
(Grant AF-AFOSR-0382-87; AF Proj. 2313)
(AD-A219927; AFOSR-90-0360TR) Avail: NTIS HC A01/MF A01 CSCL 06/4

Experiments on auditory perception of temporal interval, pitch, and timbre are outlined. Reference to more detailed articles in press are provided. Articles on auditory timing have appeared in perception and psychophysics. GRA

**N90-23873#** Zurich Univ. (Switzerland). Neurology Clinic.
**NEUROTRANSMITTER AND PEPTIDE LOCALIZATION IN HUMAN BRAIN Final Report, 1 May 1986 - 30 Apr. 1989**
Victoria Chan-Palay 13 Mar. 1990 6 p
(Grant AF-AFOSR-0176-86; AF Proj. 2312)
(AD-A219964; AFOSR-90-0358TR) Avail: NTIS HC A02/MF A01 CSCL 06/4

Studies utilizing human brain tissue examined the colocalization of neurotransmitters using immunocytochemical and in vitro hybridization techniques. Results have shown the coexistance of somatostatin and neuropeptide Y in the hippocampus, and galanin and acetylcholine in the human forebrain. GRA

**N90-23874#** Aerospace Medical Research Labs., Wright-Patterson AFB, OH. Human Systems Div.
**BRAIN STEM EVOKED RESPONSES IN ALTERED G ENVIRONMENTS Interim Report, Jan. 1985 - Apr. 1986**
Glenn F. Wilson, Ralph J. Luciani, David A. Ratino, Loretta L. Floyd, and Louis E. Rodriguez Sep. 1989 16 p
(AF Proj. 7184)
(AD-A220097; AAMRL-TR-89-016) Avail: NTIS HC A03/MF A01 CSCL 05/8

Due to the importance of the vestibular system in both ground-based and space-based motion sickness, a method of measuring its activity in intact humans is desirable. Since the gravitoinertial end-organ receptors of the vestibular and auditory systems are in close proximity and share common peripheral structures, it is hypothesized that changes in the neuroelectrical activity of the otolith pathway affected by gravitoinertial off-loading could possibly influence nerve conduction in the auditory system. This could subsequently be measured by recording changes in the brain stem evoked response (BSER), providing an indirect measure of vestibular activity. BSERs were recorded from ten subjects under the cardinal static environments of +1 and -1 Gx, Gy, and Gz. No changes were found in the vestibular end organs and the auditory system were not found to interact under the conditions of this study. GRA

**N90-23875#** Army Natick Research and Development Command, MA. Soldier Science Directorate.
**A LABORATORY STUDY OF THE EFFECTS OF DIET AND BRIGHT LIGHT COUNTERMEASURES TO JET LAG Final Report, Apr. 1988 - Jun. 1989**
M. L. Moline, C. P. Pollak, S. Zendell (New York Hospital-Cornell Medical Center, NY.), L. S. Lester, C. A. Salter, and E. Hirsch Mar. 1990 97 p
(Contract DAAK60-88-C-0100; DA Proj. 1L1-62786-AH-99)
(AD-A220148; NATICK-TR-90-/024) Avail: NTIS HC A05/MF A01 CSCL 06/10

The ability of diet or bright light to prevent or alleviate jet lag was tested by simulating a 6-hour easterly time zone shift. Twenty-three male Marines lived in individual, time-isolation apartments for 15 consecutive days. Diet group subjects were put on a popularized jet lag diet (high protein breakfast, high carbohydrate dinners, scheduled caffeine consumption) for 4 days prior to the shift. Light group subjects were exposed to bright (2500 lux), full-spectrum light on the first 4 mornings after the shift. Control group subjects were maintained on a mixed nutrient, balanced diet and were exposed only to ambient light. All of the subjects experienced jet lag as evidenced by disruption in sleep patterns and body temperature rhythms. Decrements in mood, performance, and levels of physical activity were also noted. The jet lag diet actually worsened sleep and did not lessen or promote recovery from other jet lag symptoms. The bright light treatment showed the most promise for future use in that, after 2 to 3 treatments, Light group subjects tended to be more alert and happier than before the shift as well as more alert and happier than Diet and Control group subjects. However, the light regimen hindered temperature rhythm resynchronization and sleep. Additional research is needed to determine if these undesirable effects can be reduced or eliminated by modifying the intensity of the bright light and/or the timing of the treatment. GRA

**N90-23876#** BBN Systems and Technologies Corp., Canoga Park, CA.
**ANALYSES OF THE PREDICTABILITY OF NOISE-INDUCED SLEEP DISTURBANCE Final Report, 23 Feb. - 23 Dec. 1989**
Karl S. Pearsons, David S. Barber, and Barbara G. Tabachnick 17 Jan. 1990 86 p
(Contract F33615-86-C-0530; AF Proj. 3037)
(AD-A220156; BBN-7131; HSD-TR-89-029) Avail: NTIS HC A05/MF A01 CSCL 06/10

A summary of the analyses performed on 21 studies concerning the effects of noise on sleep is provided. The analyses were performed in the hope of developing a quantitative predictive model for assessing the effects of aircraft noise exposure on sleep. However, large discrepancies noted between laboratory and field studies precluded the development of such a model. The report includes a summary of the studies reviewed, the analyses undertaken, and various dose-effect relationships for awakening, and sleep stage change as a function of A-level and sound exposure level (SEL) in laboratory and field environments. The analyses include hierarchical multivariate regressions of the data of reviewed studies. Since a model for sleep disturbance could

not be developed from available information, suggestions for studies to acquire the data are provided. GRA

**N90-23877*** National Aeronautics and Space Administration, Washington, DC.
**AEROSPACE MEDICINE AND BIOLOGY: A CONTINUING BIBLIOGRAPHY WITH INDEXES (SUPPLEMENT 336)**
May 1990 49 p
(NASA-SP-7011(336); NAS 1.21:7011(336)) Avail: NTIS HC A03; NTIS standing order as PB90-912300, $11.50 domestic, $23.00 foreign CSCL 06P

This bibliography lists 111 reports, articles and other documents introduced into the NASA Scientific and Technical Information System during April 1990. Subject coverage includes: aerospace medicine and psychology, life support systems and controlled environments, safety equipment, exobiology and extraterrestrial life, and flight crew behavior and performance. Author

# 53 BEHAVIORAL SCIENCES

Includes psychological factors; individual and group behavior; crew training and evaluation; and psychiatric research.

**N90-23878#** Naval Aerospace Medical Research Lab., Pensacola, FL.
**MENTAL LAPSES AND EVENT-RELATED POTENTIALS Interim Report, 1988 - 1989**
R. R. Stanny Nov. 1989 36 p
(AD-A219454; NAMRL-1347) Avail: NTIS HC A03/MF A01 CSCL 05/8

Event-related potentials (ERPs) were recorded from 10 subjects as they performed an acoustic target detection task. Each subject's ERPs were sorted by performance level, on a trial-by-trial basis. A number of ERP measuring procedures then were compared in terms of their abilities to detect episodes of low behavioral performance. The ERP feature that proved most sensitive to fluctuations in performance was P3 (P300) amplitude. Weighted, time-averaged amplitude measures outperformed peak amplitude measures by a substantial margin. The results are discussed as they bear on using ERPs to detect lapses of equipment operator performance. GRA

**N90-23879#** Naval Submarine Medical Research Lab., Groton, CT.
**EFFECT OF EXTRANEOUS COLOR-CODED TARGETS ON IDENTIFICATION OF TARGETS ON CRT DISPLAYS Interim Report, Oct. 1988 - Oct. 1989**
Saul M. Luria, David F. Neri, Matthew J. Shim, and Robyn Bivenour 16 Jan. 1990 20 p
(AD-A219473; NSMRL-1154) Avail: NTIS HC A03/MF A01 CSCL 17/1

Sonar operations, using the broadband waterfall display, search for a thin line which constitutes a target track. Although current displays are monochromatic, color may well be added in the future. To examine the usefulness of color coding the target tracks on such displays, the response times of individuals to lines coded with different colors were measured; different sets of colors were compared; the effect of varying the background colors measured; and brightness; and the effects of different colors of ambient lighting were measured. These studies have shown that operators can handle as many as 20 different colors without undue confusion, that color recognition is best with a background of intermediate gray rather than white or black, that performance is the same with black and blue backgrounds, and that the color of the ambient light does not affect performance with CRT displays. Currently, the basic problem is how many different colors can be used to code different tracks without undue confusion. As noted it was found that a surprisingly large number of colors can be recognized and recalled without undue confusion on the part of the operator. These studies, however, presented only one color-coded target at a time. The present study sought to determine to what extent the CRT operator's performance is affected by the presence on the screen of several target tracks, in different colors. GRA

**N90-23880#** Naval Postgraduate School, Monterey, CA.
**ANALYSIS OF THE ACCURACY OF A PROPOSED TARGET MOTION ANALYSIS PROCEDURE M.S. Thesis**
Bernabe C. Cuberos Sep. 1989 66 p
(AD-A219481) Avail: NTIS HC A04/MF A01 CSCL 17/11

The accuracy is investigated for the recently proposed passive bearings-only Target Motion Analysis (TMA) procedure. The primary method of analysis is to compare computer generated positions of a Target that is moving with a constant course and speed, with the procedurally derived estimated positions. A computer model was developed which simulated several possible interactions between the Target and Own Ship. Estimated parameters of the Target track were computed using the procedure under analysis. These values were compared to the true values generated by the simulation. An analysis of the TMA procedure as originally proposed showed that it failed to accurately estimate the target track parameters. However with some modifications, the accuracy improved significantly and it is felt that the procedure can accurately estimate target range (but not necessarily course and speed) for some target geometries. GRA

**N90-23881#** Research Inst. of National Defence, Stockholm (Sweden). Dept. of Human Studies.
**TARGET SELECTION IN ANTI-TANK HELICOPTER OPERATIONS: RELATIVE WEIGHT OF CUES IN TARGET EVALUATION JUDGEMENTS**
Anders Carlstroem Nov. 1989 20 p
(FOA-C-50072-5.2; ISSN-0347-7665; ETN-90-96592) Avail: NTIS HC A03/MF A01

Target evaluation judgements in anti-tank helicopter operations were studied using policy capturing. The subjects were Swedish army helicopter pilots with different levels of experience of anti-tank helicopters and a group of helicopter mechanics. The results showed that the cues tactical importance of target and clarity received high weights while the cue distance to target received weight near zero. It is possible that pilots pay only small attention to distance due to confidence in the weapon system as long as it is operated within its normal range. ESA

**N90-23882#** Research Inst. of National Defence, Stockholm (Sweden). Dept. of Human Studies.
**TARGET SELECTION IN ANTI-TANK OPERATIONS: EFFECTS OF EXPERIENCE**
Anders Carlstroem Nov. 1989 21 p
(FOA-C-50073-5.2; ISSN-0347-7665; ETN-90-96593) Avail: NTIS HC A03/MF A01

Target evaluation judgements in anti-tank helicopter operations were studied using policy capturing with clarity, importance of target, and threat as cues. The subjects were helicopter pilots from U.S. and the Swedish army aviation with different levels of experience. The general finding was an overall similarity in judgements showing clarity to have the highest weight for decision to fire a missile. However, for scout helicopter pilots threat received the highest weight. The divergence could be explained by difference in experience. The results could have application for tactical training. ESA

**N90-23883#** Research Inst. of National Defence, Stockholm (Sweden). Dept. of Human Studies.
**MODE OF PRESENTATION OF CUES IN POLICY CAPTURING: A COMPARISON BETWEEN VERBAL AND PICTORIAL PRESENTATION OF TARGETS IN JUDGEMENT OF PROBABILITY TO FIRE**
Anders Carlstroem Nov. 1989 23 p
(FOA-C-50074-5.2; ISSN-0347-7665; ETN-90-96594) Avail: NTIS HC A03/MF A01

The effect of differences in modes of cue format on ratings of cues in a target selection task was studied using policy capturing. Two different modes of presentation were used: written description

versus photographic slides. The subjects were U.S. and Swedish army aviators. In the written description situation the subjects used two cues and in the pictorial situation only one cue for their judgement. Concerning which cue was most important, the utility/transport helicopter pilots made the same judgement in the two conditions while the attack/anti-tank helicopter pilots made different judgements in the two situations. It is possible that this difference is due to divergences in personal involvment in the situations presented. The difference in utilization of the cues in the two modes of presentation should be noticed in tactical training. ESA

**N90-23884#** Pennsylvania Univ., Philadelphia.
**NEUROMORPHIC OPTICAL SIGNAL PROCESSING AND IMAGE UNDERSTANDING FOR AUTOMATED TARGET RECOGNITION**
Nabil H. Farhat Dec. 1989 95 p Sponsored by ONR, Boston, MA
(AD-A219827; EO/MO-89-1) Avail: NTIS HC A05/MF A01 CSCL 12/9

The goal of research is study of computation and learning in neural net models and demonstration of their utility in image understanding and neuromorphic information processing systems for remote sensing and target identification. The approach to achieving this goal has two facets. One is combining innovative architectures and methodologies with suitable algorithms to exploit existing and emerging photonic technology in the implementation of large-scale neurocomputers for use in: the study of complex self-organizing and learning systems, fast solution of optimization problems, feature extraction, (formation of object representation), and pattern recognition. The second facet of the approach is to demonstrate and assess the capabilities of neuromorphic processing in solution of selected inverse-scattering and recognition problems. The problem studied as a test bed for the work is that of automated radar target recognition because of the existing capabilities and expertise in this area. GRA

**N90-23885#** California Univ., Santa Barbara.
**HAND SHAPING: A PARADIGM FOR COGNITIVE/MOTORIC INTERACTION Final Report, 1 Jul. 1987 - 31 Dec. 1989**
Roberta L. Klatzky and James W. Pellegrino 10 Feb. 1990 6 p
(Grant AF-AFOSR-0230-87; AF Proj. 2313)
(AD-A219908; AFOSR-90-0359TR) Avail: NTIS HC A02/MF A01 CSCL 05/8

The research efforts during the contract period resulted in three submitted or published papers and one doctoral dissertation. The papers reported: a series of experiments demonstrating that activation of a hand-shape representation could facilitate subsequent judgements about actions on objects; an investigation of preshaping during responses to objects; and the development of a controlled object-display system to measure response time and movement time. A series of experiments demonstrating that priming of a hand shape was disrupted by simultaneous preparation for a sequence of finger responses but not by preparation for a sequence of spoken syllables were reported. In general, the results suggest a cognitive/motoric representation of the hand with which actions on objects can be internally modeled, and which may serve a preparatory role in performance. GRA

**N90-23886#** Harvard Univ., Cambridge, MA. Dept. of Psychology.
**DURIP: COMPUTATIONAL MODELING OF COGNITIVE PROCESSES Final Report, 1 Dec. 1988 - 30 Nov. 1989**
Stephen M. Kosslyn 6 Mar. 1990 5 p
(Grant AF-AFOSR-0090-89; AF Proj. 3842)
(AD-A219934; AFOSR-90-0361TR) Avail: NTIS HC A01/MF A01 CSCL 05/8

The equipment purchased under this grant consisted of three VAX stations and two Macintosh II systems. The equipment was used by three major investigators and a large number of their graduate students for such purposes as speech analysis and synthesis and stimulus construction, connectionist modeling of visual systems, experimentation and perception, attention and memory, and the effects of representational format on transfer effects in learning. Nearly 20 publications resulted or are in press in addition to several presentations at national and international scientific meetings. GRA

# 54 MAN/SYSTEM TECHNOLOGY AND LIFE SUPPORT

Includes human engineering; biotechnology; and space suits and protective clothing.

For related information see also *16 Space Transportation.*

**N90-23887*#** Behavioral Health Systems, Inc., Ossining, NY.
**VOICE MEASURES OF WORKLOAD IN THE ADVANCED FLIGHT DECK: ADDITIONAL STUDIES Final Report**
Sid J. Schneider and Murray Alpert Washington NASA Nov. 1989 38 p
(Contract NAS1-18278)
(NASA-CR-4258; NAS 1.26:4258) Avail: NTIS HC A03/MF A01 CSCL 05H

These studies investigated acoustical analysis of the voice as a measure of workload in individual operators. In the first study, voice samples were recorded from a single operator during high, medium, and low workload conditions. Mean amplitude, frequency, syllable duration, and emphasis all tended to increase as workload increased. In the second study, NASA test pilots performed a laboratory task, and used a flight simulator under differing work conditions. For two of the pilots, high workload in the simulator brought about greater amplitude, peak duration, and stress. In both the laboratory and simulator tasks, high workload tended to be associated with more statistically significant drop-offs in the acoustical measures than were lower workload levels. There was a great deal of intra-subject variability in the acoustical measures. The results suggested that in individual operators, increased workload might be revealed by high initial amplitude and frequency, followed by rapid drop-offs over time. Author

**N90-23888#** Naval Aerospace Medical Research Lab., Pensacola, FL.
**EFFECT OF LASER GLARE AND AIRCRAFT WINDSCREEN ON VISUAL SEARCH PERFORMANCE UNDER LOW AMBIENT LIGHTING Interim Report, 1 Oct. 1987 - 1 Oct. 1988**
John A. DAndrea and James C. Knepton 20 Nov. 1989 23 p
(AD-A219456; NAMRL-1350) Avail: NTIS HC A03/MF A01 CSCL 06/10

Laser illumination of an aircraft may produce intense glare and degrade visually guided human performance. It is possible that disruption of aircrew performance will occur even at laser glare intensities well below the levels that produce eye damage. However, the degree of disruption of visual performance is probably influenced by a variety of factors, including windscreen characteristics and ambient illumination. To determine the interaction of an aircraft windscreen and low-level laser illumination on visual search performance, human subjects were exposed to three laser power densities while seated in a passive cockpit simulator. The subjects performed a visual search by scanning 120 randomly placed disks projected on a screen. The task consisted of detecting and reporting the location of a single smaller target disk randomly placed among the background disks. On different test sessions subjects, under low ambient lighting (1 to 3 cd/m2), either viewed the task through an aircraft windscreen or with the windscreen removed. Laser light (514 nm) was projected toward the subject from the center of the disk array on the projection screen using a fiber-optic light guide. Visual search time to locate target disks viewed through the windscreen was significantly longer compared to no windscreen and depended on the intensity of the laser produced glare. GRA

**N90-23889#** Naval Air Development Center, Warminster, PA. Dept. of Air Vehicle and Crew Systems Technology.
**DAZZLING GLARE: PROTECTION CRITERIA VERSUS VISUAL PERFORMANCE Interim Report, Sep. 1985 - Aug. 1990**
James B. Sheehy 7 Jun. 1989 22 p Sponsored by Naval Air Systems Command, Washington, DC
(AD-A219676; NADC-89076-60) Avail: NTIS HC A03/MF A01 CSCL 06/4

Laser eye protection was first introduced into the U.S. Fleet when the need arose to protect aviators and aircrew from neodymium systems. This protection was designed to reduce the incidence energy below the maximum permissible exposure level established by the American National Standards Institute. Since range finders used an infrared wavelength, as defined and therefore not visible to the eye, there was no possibility of glare. With time more systems were developed employing lasers in both the visible and infrared portion of the spectrum. When the lasing of the police helicopter in Los Angeles was first reported in 1981 it immediately became apparent that for wavelengths in the visible portion of the spectrum substantial losses in visual performance could be encountered at safe exposure levels. The incident emphasized the need to develop laser eye protection based on criteria that encompassed both transient (glare) and permanent (burns, hemorraghic lesions) effects. The goal of this research project was to establish protection levels based on performance rather than damage criteria. GRA

**N90-23890#** Illinois Univ., Champaign. Dept. of Psychology.
**ADDING A DIMENSION: TIME AS A FACTOR IN THE GENERALIZABILITY OF PREDICTIVE RELATIONSHIPS Interim Report**
Charles L. Hulin, Rebecca A. Henry, and Sharon L. Noon Jan. 1990 37 p Submitted for publication
(Contract F33615-87-C-0014)
(AD-A219679; AFHRL-TP-89-67) Avail: NTIS HC A03/MF A01 CSCL 05/8

An analysis of trends in predictive validity coefficients across time and repeated performance assessments shows highly significant and consistent trends in validities as a function of time and/or interpolated practice. Commonly used ability measures show decreasing predictive validities for the prediction of temporally more remote performance assessments. Within study corrections for differential restrictions of range and attenuation due to unreliability across the different performance assessments increased the negative slopes of the regressions of predictive validity on time or ordinal position of performance assessment. The median validity decrement from initial to final performance assessment, corrected for differential range restriction, attenuation, and within study sampling fluctuations was -.29. The mean of the trimmed distribution of corrected validity decrements, after eliminating the two most extreme cases, was -.45. The average within study correlation between predictive validity and time or ordinal position of performance assessment was 0.80. A similar analysis of stability coefficients of time period-by-time period or trial-by-trial performance assessment correlations revealed very similar albeit slightly more consistent findings. Theoretical explanations stressing the dynamic nature of human abilities, the changing nature of abilities required for task performance, and social competition factors are discussed as reasons for the predictive validity decrements. GRA

**N90-23891#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**THE APPLICATION OF KRIGING IN THE STATISTICAL ANALYSIS OF ANTHROPOMETRIC DATA, VOLUME 1 M.S. Thesis**
Michael Grant Mar. 1990 77 p Sponsored by Aerospace Medical Research Labs., Wright-Patterson AFB, OH
(AD-A220613; AFIT/GOR/ENY/ENS/90M-8-Vol-1) Avail: NTIS HC A05/MF A01 CSCL 23/2

Quality flight equipment is essential to flight crew safety and performance. Oxygen masks, night-vision goggles, and other apparatus must fit crew members comfortably and with complete functional precision. A problem currently facing the Air Force is the inconsistent quality of flight equipment. As new equipment is developed to improve crew members' performance, the requirement for design engineers to accurately account for the shape and variability of facial features becomes more critical. The application of kriging in the statistical analysis of anthropometric data is developed to support improvements in the design of flight equipment. Specifically, the geostatistical estimation technique of kriging is used to estimate the facial surfaces which influence the designs of flight apparatus. These surfaces account for the shape of the facial features and minimize the variance between individuals. A Kalman filter is developed to update and aggregate the kriged surfaces. As a proof of concept study, the techniques are demonstrated using data to support the design of the night-vision goggles currently under development. To further enhance the surface estimates, a multivariate analysis is performed to identify the factors which account for the majority of the variability between faces and to group the faces into homogenous clusters. GRA

**N90-23892#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**THE APPLICATION OF KRIGING IN THE STATISTICAL ANALYSIS OF ANTHROPOMETRIC DATA, VOLUME 2 M.S. Thesis**
Michael Grant Mar. 1990 256 p Sponsored by Aerospace Medical Research Labs., Wright-Patterson AFB, OH
(AD-A220614; AFIT/GOR/ENY/ENS/90M-8-Vol-2) Avail: NTIS HC A12/MF A02 CSCL 23/2

The application of kriging in the statistical analysis of anthropometric data to support improvements in the design of flight equipment was developed. Specifically, the geostatistical estimation technique of kriging is used to estimate the facial surfaces which influence the designs of flight apparatus. This appendix provides a graphical representation of the facial data used. The first 25 subjects were included in the trend analysis and the final variogram analysis. The next five subjects were used in the kriging and updating analysis. Following these subjects are a group of five faces which were used only in the trend analysis. The last two faces were considered for the analysis but discarded because of short falls in the data. GRA

**N90-23893#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**THE APPLICATION OF KRIGING IN THE STATISTICAL ANALYSIS OF ANTHROPOMETRIC DATA, VOLUME 3 M.S. Thesis**
Michael Grant Mar. 1990 110 p Sponsored by Aerospace Medical Research Labs., Wright-Patterson AFB, OH
(AD-A220615; AFIT/GOR/ENY/ENS/90M-8-Vol-3) Avail: NTIS HC A06/MF A01 CSCL 23/2

The application of kriging in the statistical analysis of anthropometric data to support improvements in the design of flight equipment was developed. Specifically, the geostatistical estimation technique of kriging is used to estimate the facial surfaces which influence the designs of flight apparatus. A Kalman filter is developed to update and aggregate the kriged surfaces. As a proof of concept study, the techniques are demonstrated using data to support the design of the night-vision goggles currently under development. The program contained in this appendix was used for labeling the coordinates of the aligned data points. The alignment program is not included. GRA

**N90-23894#** Pennsylvania State Univ., University Park. Dept. of Civil Engineering.
**A COMPARATIVE ANALYSIS OF WORK-HOUR FORECASTING TECHNIQUES AT THE CREW LEVEL M.S. Thesis**
James M. Pace Dec. 1989 118 p
(Contract N00228-85-G-3278)
(AD-A220706) Avail: NTIS HC A06/MF A01 CSCL 05/9

Several different methods can be used to forecast the productivity of labor-intensive construction activities. The results from three widely used method, percent complete, learning curve and standard productivity curve were used to test the practicality

of a new forecasting method, the Factor Model, for a single masonry project. Forecasts were made at weekly intervals and then compared with the actual productivity at project completion. All of the methods produced divergent forecasts throughout the first third of the activity. However, the factor model produced a forecast within 4 percent of the final productivity after only 3 percent of the work had been completed. While this research did not show that the factor model produced more accurate forecasts than the other methods, it did show that the forecasts were equally accurate. Thus, it appears that the factor model is a plausible alternative to conventional forecasting techniques. GRA

**N90-23895#** Federal Aviation Administration, Oklahoma City, OK. Civil Aeromedical Administration.
**EFFECTS OF MONITORING UNDER HIGH AND LOW TASKLOAD ON DETECTION OF FLASHING AND COLORED RADAR TARGETS Final Report**
Richard I. Thackray and R. Mark Touchstone Jan. 1990 17 p Sponsored by FAA, Washington, DC
(AD-A220313; DOT/FAA/AM-90/3) Avail: NTIS HC A03/MF A01 CSCL 17/9

While midair collisions between aircraft are extremely rare occurrences, near midair incidents are more common. The present study sought to evaluate the gains in conspicuity that might be realized if flashing or color were added as redundant cues to indicate the presence of unexpected, nontracked aircraft entering controlled airspace and to examine the extent to which increased taskload and fatigue might influence the expected gains. Sixty-four subjects monitored a simulated air traffic control task over a 2-hour period for possible conflict situations (their primary task) under either high or low primary taskload conditions. They also monitored for occasional intrusions by light aircraft identifiable on the basis of target shape alone or with color and/or flashing added as redundant cues. Flashing as a redundant cue was found to be superior to color in all aspects tested; unlike color, detection of flashing targets was unaffected by screen location and by changes in primary taskload. Flashing was also least affected by monitoring fatigue. It was concluded that the superiority of flashing over color in attracting attention to objects in a display must be weighed against its possible potential for distraction. A practical means of accomplishing this in operational situations is through the use of touch sensitive displays to both acknowledge/confirm target location and to deactivate flashing. GRA

**N90-23896#** Technische Univ., Berlin (Germany, F.R.). Inst. fuer Luft- und Raumfahrt.
**LUNAR SHELTER**
Andreas Kuechler and Roland Glasmachers 1989 53 p In GERMAN
(ILR-Mitt-233(1989); ETN-90-96484) Avail: NTIS HC A04/MF A01

A lunar shelter for a future Moon base in the year 2005 is described. It allows the survival of six persons for a minimum of 18 days. The characteristic values of the lunar shelter (length 9.6 m, diameter 4.2 m, mass 20 tons) were evaluated by the transport systems Space Shuttle 2, Advanced Launch System and LTV (Lunar Transportation Vehicle). All vital systems must be manually adjustable in case of computer breakdown. The lunar shelter must be designed for a lifetime of 10 years. The LTV places the lunar shelter on its longitudinal axis parallel to the Moon equator. The nuclear energy supply must be taken into consideration to minimize the radioactive charge of the astronauts. A fiberglass covering is used to protect the structure from the atmospheric stresses. Tables and diagrams show the predicted costs and the possibilities of their reduction. ESA

# 55 SPACE BIOLOGY

Includes exobiology; planetary biology; and extraterrestrial life.

**N90-23897*#** Wisconsin Univ., Milwaukee.
**THE BIOGEOCHEMISTRY OF METAL CYCLING**
Kenneth H. Nealson, ed., Molly Nealson, ed., and F. Ronald Dutcher, ed. (George Washington Univ., Washington, DC.) Washington NASA May 1990 220 p
(Contract NASw-4324)
(NASA-CR-4295; NAS 1.26:4295) Avail: NTIS HC A10/MF A02 CSCL 03B

The results of the Planetary Biology and Microbial Ecology's summer 1987 program are summarized. The purpose of the interdisciplinary PBME program is to integrate, via lectures and laboratory work, the contributions of university and NASA scientists and student interns. The 1987 program examined various aspects of the biogeochemistry of metal cycling, and included such areas as limnology, metal chemistry, metal geochemistry, microbial ecology, and interactions with metals. A particular area of focus was the use of remote sensing in the study of biogeochemistry. Abstracts and bibliographies of the lectures and reports of the laboratory projects are presented. Author

# 59 MATHEMATICAL AND COMPUTER SCIENCES (GENERAL)

**N90-23898*#** Institute for Computer Applications in Science and Engineering, Hampton, VA.
**CUMULATIVE REPORTS AND PUBLICATIONS THROUGH DECEMBER 31, 1989 Final Report**
May 1990 70 p
(Contracts NAS1-18605; NAS1-18107; NAS1-17070; NAS1-17130; NAS1-15810; NAS1-16394; NAS1-14101; NAS1-14472)
(NASA-CR-182041; NAS 1.26:182041) Avail: NTIS HC A04/MF A01 CSCL 12A

A complete list of reports from the Institute for Computer Applications in Science and Engineering (ICASE) is presented. The major categories of the current ICASE research program are: numerical methods, with particular emphasis on the development and analysis of basic numerical algorithms; control and parameter identification problems, with emphasis on effectual numerical methods; computational problems in engineering and the physical sciences, particularly fluid dynamics, acoustics, structural analysis, and chemistry; computer systems and software, especially vector and parallel computers, microcomputers, and data management. Since ICASE reports are intended to be preprints of articles that will appear in journals or conference proceedings, the published reference is included when it is available. Author

**N90-23899*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**ADVANCING AUTOMATION AND ROBOTICS TECHNOLOGY FOR THE SPACE STATION FREEDOM AND FOR THE US ECONOMY Progress Report No. 10, 13 Jul. 1989 - 14 Feb. 1990**
Jun. 1990 37 p
(NASA-TM-102668; NAS 1.15:102668) Avail: NTIS HC A03/MF A01 CSCL 12A

In April 1985, the NASA Advanced Technology Advisory Committee (ATAC) reported to Congress the results of its studies on advanced automation and robotics technology for use on Space Station Freedom. This material was documented in the initial report (NASA Technical Memorandum 87566). The progress made by Levels 1, 2, and 3 of the Office of Space Station in developing and applying advanced automation and robotics technology are described. Emphasis was placed upon the Space Station Freedom Program responses to specific recommendations made in ATAC Progress Report 9, the Flight Telerobotic Servicer, the Advanced

Development Program, and the Data Management System. Assessments are presented for these and other areas as they apply to the advancement of automation and robotics technology for the Space Station Freedom. Author

**N90-23900#** Amsterdam Univ. (Netherlands). Inst. for Language, Logic and Information.
**ON THE EARLY HISTORY OF INTUITIONISTIC LOGIC**
A. S. Troelstra Aug. 1988 23 p In DUTCH and ENGLISH Submitted for publication
(ITLI-LP-89-04; ETN-90-96913) Avail: NTIS HC A03/MF A01

Kolmogorov's first paper and the work of Glivenko and Heyting are discussed. The Brouwer-Heyting-Kolmogorov interpretation is reported. Letters between researchers are given. ESA

**N90-23901#** Amsterdam Univ. (Netherlands). Inst. for Language, Logic and Information.
**REMARKS ON INTUITIONISM AND THE PHILOSOPHY OF MATHEMATICS**
A. S. Troelstra Nov. 1988 19 p Presented at Heyting 1988, Chaika near Varna, Bulgaria, 13-23 Sep. 1988 Revised
(ITLI-LP-88-05; ETN-90-96914) Avail: NTIS HC A03/MF A01

A sketch of the overall picture of the foundations of mathematics just before 1930 is given. Further topics discussed include: absolute and relative certainty; mathematics as the science of idealized structures; the role of language; formalization and the evidence for axioms; examples of informal rigor and concept analysis; actualism, intuitionism and platonism; certainty; equality in constructive mathematics. ESA

# 60 COMPUTER OPERATIONS AND HARDWARE

Includes hardware for computer graphics, firmware, and data processing.

For components see *33 Electronics and Electrical Engineering.*

**N90-23902#** Computer Sciences Corp., Falls Church, VA.
**SOFTWARE TECHNIQUES FOR NON-VON NEUMANN ARCHITECTURES Final Technical Report, Feb. 1988 - Jun. 1989**
Chris Lightfoot, Doug Sakal, Tim Busse, Jerry Shelton, Ralph Duncan, and Tom Cheatham (Software Options, Inc., Cambridge, MA.) Jan. 1990 213 p
(Contract F30602-87-D-0092; AF Proj. 5581)
(AD-A220390; RADC-TR-89-337) Avail: NTIS HC A10/MF A02 CSCL 12/5

This report examines the use of non-sequential (Non-von Neumann) technology for the support of command and control applications. It has become apparent that the utilization of traditional von-Neumann computers is insufficient of many applications. The utilization of Non-von Neumann Architectures is needed to satisfy these computational requirements. In order to assess the utility of Non-von Neumann Architectures, three tasks were performed: (1) A comprehensive survey of existing Non-von Neumann Architectures and development of a new taxonomy, classifying Non-von Neumann Architectures according to structure and capability; (2) Based on the architecture survey and classification scheme, a determination of how these architectures are currently applied as well as their potential use in C3I applications was made; (3) An assessment of how these Non-von Neumann based architectures can be utilized over the entire system and software life cycle. GRA

**N90-23903#** Norwegian Defence Research Establishment, Kjeller. Forsvarets Forskningsinst.
**CESAR LOCAL BUS**
Kjell Arvid Andersen and Ivar Tansem 18 Jul. 1989 25 p
(FFI-89/7011; ISSN-0802-2437; ETN-90-96570) Avail: NTIS HC A03/MF A01

A BUS specification of CESAR LOCAL BUS is presented. LOCAL BUS (LBUS) is a synchronous bus for data transfer. The 101 signals contained in LBUS are described. Data transfer is detailed in terms of addressing, transfer modes and lines, memory cycle times and timing/sequence diagrams. BUS driver specifications are given. Backplane termination network is explained and LBUS backplane connectors described. ESA

**N90-23904#** Universiteit Twente, Enschede (Netherlands). Dept. of Computer Science.
**TUMULT-64: A REAL-TIME MULTI-PROCESSOR SYSTEM**
Pierre G. Jansen and Gerard J. M. Smit Nov. 1989 14 p
(Memo-INF-89-58; ISSN-0923-1714; ETN-90-96754) Avail: NTIS HC A03/MF A01

TUMULT, a modular extendible multi-processor system, is described. Nodes communicate via a high performance switching network. Processors within a node communicate via a shared memory. A distributed real-time operating system was designed and implemented, offering high performance communication facilities at application level. Communication is made location transparant by mailboxes. Processes can connect dynamically to mailboxes after which they may pass messages or call remote procedures. The system's architectural and communication aspects are emphasized. ESA

**N90-23905#** Universiteit Twente, Enschede (Netherlands). Dept. of Computer Science.
**AREA-TIME EFFICIENT ADDERS**
G. R. TjonJoekTjien Dec. 1989 86 p
(Memo-INF-89-61; ISSN-0923-1714; ETN-90-96755) Avail: NTIS HC A05/MF A01

A path expression model of a rule-based operating system is presented. In the system considered, path expressions, with a number of extensions are used as restrictive rules, active commands or even as a mixture of rules and commands. Path expressions were introduced as a high level mechanism for the synchronization of operations on abstract data types. They are a powerful tool to express restrictions on the order in which tasks may be executed in a multi-process environment. Path expressions can also be used as a command language allowing complex commands. ESA

**N90-23906#** Universiteit Twente, Enschede (Netherlands). Dept. of Computer Science.
**A MODEL OF A PATH EXPRESSION BASED OPERATING SYSTEM SHELL**
J. J. Luursema Dec. 1989 29 p
(Memo-INF-89-71; ISSN-0923-1714; ETN-90-96757) Avail: NTIS HC A03/MF A01

A path expression model of a rule-based operating system is presented. In the system considered, path expressions, with a number of extensions are used as restrictive rules, active commands or even as a mixture of rules and commands. Path expressions were introduced as a high level mechanism for the synchronization of operations on abstract data types. They are a powerful tool to express restrictions on the order in which tasks may be executed in a multi-process environment. Path expressions can also be used as a command language allowing complex commands. ESA

**N90-23907#** Northwestern Univ., Evanston, IL. Inst. for the Learning Sciences.
**MEMORY-BASED EXPERT SYSTEMS Final Report, 1 Nov. 1988 - 30 Jun. 1989**
Roger C. Schank 30 Jun. 1989 5 p
(Grant AF-AFOSR-0100-89; AF Proj. 6101)
(AD-A219875; AFOSR-90-0346TR) Avail: NTIS HC A01/MF A01 CSCL 12/9

The purpose of this project was to explore new possibilities for representation and retrieval of knowledge. Building on our work in knowledge representation and memory organization, we built alternatives to the rule-based approach to expert systems. We tried instead to model the powerful capacity people have to generalize their knowledge across numerous domains. We believe

that our explanation in this area will lead to flexible and robust methods for creating automated reasoning and problem-solving systems. GRA

**N90-23908#** Massachusetts Inst. of Tech., Cambridge. Artificial Intelligence Lab.
**THE STANDARD MAP MACHINE**
Brian LaMacchia and Jason Nieh Sep. 1989 47 p
(Contract N00014-86-K-0180)
(AD-A219943; AIM-1165) Avail: NTIS HC A03/MF A01 CSCL 12/6

The Standard Map Machine (SMM) is designed as an answer to the intensive computational requirements involved in the study of chaotic behavior in nonlinear systems. The high-speed and high-precision performance of this computer is due to its simple architecture specialized to the numerical computations required of nonlinear systems. This report will discuss the design and implementation of this special-purpose machine. GRA

**N90-23909#** Air Force Geophysics Lab., Hanscom AFB, MA. Aerospace Instrumentation Div.
**THE ZENITH Z-248 AS A SCIENTIFIC WORKSTATION Interim Report**
R. R. Babcock, R. E. McInerney, B. T. Bancroft, and R. J. Raistrick 1 Sep. 1989 49 p
(AD-A219991; GL-TR-89-0174; GL-IP-338) Avail: NTIS HC A03/MF A01 CSCL 12/6

This report reviews the development of the desktop computer and workstation for scientific data analysis and develops the basic concepts of connectivity, processing power, high-resolution graphical displays, and large local data storage that support the creation of the scientific workstation approach to geophysical data analysis. The report reviews the capabilities of the basic Z-248 configuration and identifies key enhancements in memory expansion, high resolution displays, added storage, and networking capabilities that can turn the Z-248 into a scientific workstation. GRA

# 61 COMPUTER PROGRAMMING AND SOFTWARE

Includes computer programs, routines, alogorithms, and specific applications, e.g., CAD/CAM.

**N90-23910*#** Research Inst. for Advanced Computer Science, Moffett Field, CA.
**THE INTERNET WORM**
Peter J. Denning 7 Feb. 1989 16 p
(Contract NCC2-387)
(NASA-CR-181576; NAS 1.26:181576; RIACS-TR-89.3) Avail: NTIS HC A03/MF A01 CSCL 09B

In November 1988 a worm program invaded several thousand UNIX-operated Sun workstations and VAX computers attached to the Research Internet, seriously disrupting service for several days but damaging no files. An analysis of the work's decompiled code revealed a battery of attacks by a knowledgeable insider, and demonstrated a number of security weaknesses. The attack occurred in an open network, and little can be inferred about the vulnerabilities of closed networks used for critical operations. The attack showed that passwork protection procedures need review and strengthening. It showed that sets of mutually trusting computers need to be carefully controlled. Sharp public reaction crystalized into a demand for user awareness and accountability in a networked world. Author

**N90-23911*#** Research Inst. for Advanced Computer Science, Moffett Field, CA.
**A DISTRIBUTED PROGRAM COMPOSITION SYSTEM**
Robert L. Brown Feb. 1989 127 p
(Contract NCC2-387)
(NASA-CR-181568; NAS 1.26:181568; RIACS-TR-89.6) Avail: NTIS HC A07/MF A01 CSCL 09B

A graphical technique for creating distributed computer programs is investigated and a prototype implementation is described which serves as a testbed for the concepts. The type of programs under examination is restricted to those comprising relatively heavyweight parts that intercommunicate by passing messages of typed objects. Such programs are often presented visually as a directed graph with computer program parts as the nodes and communication channels as the edges. This class of programs, called parts-based programs, is not weil supported by existing computer systems; much manual work is required to describe the program to the system, establish the communication paths, accommodate the heterogeneity of data types, and to locate the parts of the program on the various systems involved. The work described solves most of these problems by providing an interface for describing parts-based programs in this class in a way that closely models the way programmers think about them: using sketches of diagraphs. Program parts, the computational modes of the larger program system are categorized in libraries and are accessed with browsers. The process of programming has the programmer draw the program graph interactively. Heterogeneity is automatically accommodated by the insertion of type translators where necessary between the parts. Many decisions are necessary in the creation of a comprehensive tool for interactive creation of programs in this class. Possibilities are explored and the issues behind such decisions are presented. An approach to program composition is described, not a carefully implemented programming environment. However, a prototype implementation is described that can demonstrate the ideas presented. Author

**N90-23912*#** Institute for Computer Applications in Science and Engineering, Hampton, VA.
**THE COST OF CONSERVATIVE SYNCHRONIZATION IN PARALLEL DISCRETE EVENT SIMULATIONS Final Report**
David M. Nicol (College of William and Mary, Williamsburg, VA.) May 1990 32 p Submitted for publication Sponsored in part by Virginia Center for Innovative Technology
(Contract NAS1-18605; NAG1-060; NSF ASC-88-19393)
(NASA-CR-182034; NAS 1.26:182034; ICASE-90-20) Avail: NTIS HC A03/MF A01 CSCL 09B

The performance of a synchronous conservative parallel discrete-event simulation protocol is analyzed. The class of simulation models considered is oriented around a physical domain and possesses a limited ability to predict future behavior. A stochastic model is used to show that as the volume of simulation activity in the model increases relative to a fixed architecture, the complexity of the average per-event overhead due to synchronization, event list manipulation, lookahead calculations, and processor idle time approach the complexity of the average per-event overhead of a serial simulation. The method is therefore within a constant factor of optimal. The analysis demonstrates that on large problems--those for which parallel processing is ideally suited--there is often enough parallel workload so that processors are not usually idle. The viability of the method is also demonstrated empirically, showing how good performance is achieved on large problems using a thirty-two node Intel iPSC/2 distributed memory multiprocessor. Author

**N90-23913#** Johns Hopkins Univ., Laurel, MD. Applied Physics Lab.
**EVALUATION METHODOLOGY FOR SOFTWARE ENGINEERING Final Report, 1 Nov. 1988 - 31 Oct. 1989**
Bruce I. Blum Dec. 1989 16 p
(Grant AF-AFOSR-0080-89; AF Proj. 2304)
(AD-A218474; AFOSR-90-0215TR; RMI-89-028) Avail: NTIS HC A02/MF A01 CSCL 12/5

This is the final report on research intended to investigate the most effective methods for software engineering evaluation. The objective of this work is to identify and evaluate the methods used to measure the impact of changes to the software process. In particular, there is a special interest in the evaluation of benefit

improvements when different process models are used. The research has pursued two types of activity. First, evaluation methods used in other disciplines were reviewed for their utility in software engineering. The long-term goal is to produce a taxonomy of methods with a suggested range of strengths for software engineers. The availability of this unified view would help analysts select the most appropriate evaluation techniques for a given class of task. The second class of activity employed small studies in which evaluation methods could be tested and/or quantifiable concepts could be modeled. Because the research goal is to provide a means to appraise alternative development paradigms, most of the effort was spent on the study of an essential software process model (i.e., a meta-process model) and the evaluation of paradigms that alter the process within the model. GRA

**N90-23914#** Michigan Univ., Ann Arbor. Dept. of Electrical Engineering and Computer Science.
**PROCEEDING OF THE EMBEDDED AI LANGUAGES WORKSHOP Final Report, 1 Jun. 1988 - 31 Dec. 1989**
Richard A. Volz, Trevor Mudge, and Gary Lindstrom (Utah Univ., Salt Lake City.) 27 Jan. 1990 34 p Workshop held in Ann Arbor, MI, 16-18 Nov. 1988
(Contract DAAL03-88-G-0030)
(AD-A218531; ARO-25325.1-EL-CF) Avail: NTIS HC A03/MF A01 CSCL 12/9

The past five years has seen an emerging recognition of two important issues in computer science and engineering: languages and environments for distributed, embedded real-time control, and languages and environments for artificial intelligence. For the past decade, the basic concepts and techniques required for correct use of computers in real-time embedded systems were being developed. More recently, there were a growing number of artificial intelligence applications involving real-time control systems. The workshop was originally conceived to have a language focus. As the workshop unfolded, the issues became less a matter of language, and more a matter of algorithms. The goals were addressed in two ways. A small number of experts in key subareas relating to the overall problem were invited to give presentations providing an orientation to that subarea and issue challenge positions on issues remaining to be solved. Secondly, working groups were formed to identify and discuss further issues in each of the subareas. The broad goals given to each of the working groups were to formulate a definition of the problem area and develop prioritized recommendations concerning: major issues needing research; promising directions for pursuit of these issues; and identification of problems already satisfactorily addressed. GRA

**N90-23915#** Naval Ocean Research and Development Activity, Bay Saint Louis, MS.
**DIGITAL TERRAIN ELEVATION DATA COMPACT DISK-READ ONLY MEMORY PROTOTYPE EVALUATION**
Jerry L. Landrum, James E. Braud, John L. Breckenridge, and Susan V. Carter Aug. 1989 53 p
(AD-A218545; NORDA-192) Avail: NTIS HC A04/MF A01 CSCL 12/5

The Navy's evaluation of the Defense Mapping Agency's prototype Digital Terrain Elevation Data (DTED) on Compact Disk-Read Only Memory (CD-ROM) is presented. The CD-ROM medium offers large savings in cost and in storage space, and is an appropriate on-line digital data base for minicomputers and microcomputers. A brief description of the CD-ROM technology is presented along with directions for reading the DTED data. Sample applications and results are described, and recommendations are presented. GRA

**N90-23916#** Stanford Univ., CA. Dept. of Computer Science.
**AUTOMATIC RUNTIME CONSISTENCY CHECKING AND DEBUGGING OF FORMALLY SPECIFIED PROGRAMS Ph.D. Thesis**
Sriram Sankar Aug. 1989 212 p
(Contract N00039-84-C-0211)
(AD-A218855; SU-STAN-CS-89-1282) Avail: NTIS HC A10/MF A02 CSCL 12/5

An approach is studied to automate the process of deciding whether a program is performing correctly, and if not, to discover the probable cause of the problem. It assumes that the intended program's behavior is specified in some formal, high-level specification language. It studies how one can check automatically at runtime whether the program is running consistently with its specification, and if not, how inconsistencies can be automatically detected and diagnosed. A method of using this checking method for debugging formally specified programs is then presented. The consistency checking method depends on the particular specification language constructs used. Two categories of constructs are studied: generalized assertions and algebraic specifications. Generalized assertions contain boolean expressions that must be satisfied within a specified region in the underlying program. Checking functions are generated which test for the truth of these boolean expressions. Diagnostic messages are given and a debugger is invoked if there is a violation. Checking functions are called from locations in the program where the specification may have changed value. In this thesis, algebraic specifications are considered to be equations whose terms comprise abstract data type operations. Algebraic specification checking involves monitoring the execution of the abstract data type operations. GRA

**N90-23917#** Carnegie-Mellon Univ., Pittsburgh, PA. Software Engineering Inst.
**HARTSTONE: SYNTHETIC BENCHMARK REQUIREMENTS FOR HARD REAL-TIME APPLICATIONS Final Report**
Nelson Weiderman Jun. 1989 19 p
(Contract F19628-85-C-0003)
(AD-A219326; CMU-SEI-89-TR-23; ESD-TR-89-31) Avail: NTIS HC A03/MF A01 CSCL 12/7

The purpose of this paper is to define the operational concept for a series of benchmark requirements to be used to test the ability of a system to handle hard real-time applications. Implementations of such benchmarks would be useful in evaluating scheduling algorithms, protocols, and design paradigms, as well as processors, languages, compilers, and operating systems. Several Ada programs are under development to test standard versions of the benchmark requirements and will be released into the public domain. GRA

**N90-23918#** Mitre Corp., Bedford, MA.
**DISTRIBUTED OBJECT ORIENTED PROGRAMMING Final Report, Oct. 1987 - Sep. 1988**
E. H. Bensley, T. J. Brando, J. C. Fohlin, M. J. Prelle, and A. M. Wollrath Feb. 1990 61 p
(Contract F19628-86-C-0001)
(AD-A219689; RADC-TR-89-339) Avail: NTIS HC A04/MF A01 CSCL 12/5

A concurrent model of execution for object oriented programming is described. In addition, a computation manager that implements this model and a compiler that translates a subset of Common Lisp with Flavors object oriented extension to code executable by the computation manager are also described. Finally, fault tolerant resources management algorithms and a simulation of a multiprocessor system that embodies these algorithms are described. GRA

**N90-23919#** Logicon, Inc., San Pedro, CA.
**CONCEPTUAL MODELING VIA LOGIC PROGRAMMING Final Technical Report, Sep. 1987 - Mar. 1989**
John Burge, Bill Noah, and Les Smith Jan. 1990 172 p
(Contract F30602-87-D-0092; AF Proj. 5581)
(AD-A219785; LSIS-890166; RADC-TR-90-11) Avail: NTIS HC A08/MF A01 CSCL 12/5

The Conceptual Modeling via Logic Programming Task was to determine whether it is feasible to use conceptual models as a design aid for command and control systems, and whether these conceptual models can practically be implemented using logic programming. The major efforts included a review of conceptual

modeling and logic programming, development of concepts for using conceptual modeling to aid command and control designers, development of a demonstration system, and evaluation. A Quintus Prolog-based demonstration system was built. The feasibility of using conceptual modeling implemented in logic programming was established. GRA

**N90-23920#** California Univ., Marina del Rey. Information Sciences Inst.

**GENERATION OF EXPERT SYSTEMS BY PARTIAL EVALUATION**

Leonard Friedman and David P. Banjamin Jan. 1990 15 p (Contract F33600-88-C-0028)

(AD-A220427; ISI/RR-89-247) Avail: NTIS HC A03/MF A01 CSCL 12/5

Partial Evaluation (PE) is shown to be a useful technique for machine learning. The implemented version, LDS, generates expert diagnostic knowledge bases using PE. One of the benefits of the system is to simplify knowledge acquisition. PE is applicable whenever the problems to be solved share reasoning methods that can be represented by a common model with variables, and the knowledge to partially instantiate those variables is readily available. The general model used is a causal model of the failures observed in power supplies, supplemented by knowledge that links structures to function. Unlike Explanation-based Learning, learning by Partial Evaluation proceeds by specializing a general model rather than generalizing a specific example. The output of learning is a specific causal model for an input circuit and is ready to be used by the performance system, which is an expert diagnostician. GRA

**N90-23921#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

**COMPARISON OF SELECTION PROCEDURES AND VALIDATION OF CRITERION USED IN SELECTION OF SIGNIFICANT CONTROL VARIATES OF A SIMULATION MODEL M.S. Thesis**

James A. Gigliotti Mar. 1990 165 p

(AD-A220459; AFIT/GOR/ENS/90M-7) Avail: NTIS HC A08/MF A01 CSCL 12/5

The purpose of this thesis was three-fold. The first purpose was to revise and extend the capabilities of existing software for selecting the significant control variables of a simulation model, based on a newly developed selection criterion. The second purpose was to compare the results obtained using the revised software employing two different selection procedures. And the third purpose was then to validate the effectiveness of the new selection criterion by comparison to results derived using other common selection criteria. Extensive revision of the existing software was necessary to prepare it for use. Initially, the software was revised to extend its adaptability to evaluating new data and to increase user friendliness. Next, a new procedure was added to the software to permit it to evaluate data using a Stepwise (Forward Selection) procedure. Previously, the software only performed analysis of the data through an Enumerated Subsets approach. After revision of the software was complete, it was renamed the Variable Subset Selection Program (VSSP). Once the VSSP was ready, it was used to evaluate two types of data. The first type of data was created using a known stochastic structure. Three sets of this data was used, each set using a different covariance structure between the responses and control variables. The second type of data was created from an untested simulation model. GRA

**N90-23922#** Sacramento Air Logistics Center, McClellan AFB, CA.

**OOPS IT'S HAPPENING, PART 1**

Mel Fisher 31 Aug. 1989 18 p Submitted for publication

(AD-A220498; SM-ALC/SCD-1-Pt-1) Avail: NTIS HC A03/MF A01 CSCL 12/5

Since the introduction of computers, programmers have been searching for higher level languages which support a philosophy of quick and easy application development and maintenance. Problems in the 50's and 60's resulted in extensions being added to computer languages to make them more modular, thus reducing the problems of having different parts of a program conflict with each other. This module or block of code required protection from other things happening within the program and introduced the concept of an OBJECT and how to protect (encapsulate) data used by that object. One of the first oriented languages was Smalltalk, developed at Xerox PARC in 1977 by Alan Kay. It was a tremendous success at influencing the direction of many commercial products like Apple's Lisa and Macintosh. Similar to the Macintosh, the Smalltalk system is not just a language; it's an integrated programming environment. An object oriented programming (OOP) environment like Smalltalk is based on a single universal data structure (the object), a control structure for sending messages, and a uniform class description (the class hierarchy). GRA

**N90-23923#** Stanford Univ., CA. Dept. of Electrical Engineering.

**ADVANCED DEVELOPMENT ENVIRONMENTS, CONTINUATION Final Technical Report**

David C. Luckham 1989 6 p

(Contract N00039-84-C-0211)

(AD-A220510) Avail: NTIS HC A02/MF A01 CSCL 12/7

The Stanford Advanced Development Environments project is designing a new generation of machine processable languages and automated environment tools to support formal and rigorous development methods in all phases of systems production. New methodologies, based on automated applications of powerful design and specification languages, are required in order to revolutionize current methods of building, maintaining, and modifying large distributed computer systems. Formal development methodologies are the most promising emerging technology for increasing the trustworthiness of future computer systems, lowering their cost and production time, and managing the growing complexity that must be expected of twenty-first century systems. GRA

**N90-23924#** Corps of Engineers, Vicksburg, MS. Information Technology Lab.

**GUIDE FOR THE USE OF INTERGRAPH RANDMICAS STRUCTURAL SOFTWARE FOR COMPUTER-AIDED DESIGN AND DRAFTING(CADD) Final Report, Jan. 1987 - Dec. 1988**

Feb. 1990 72 p Sponsored by Corps of Engineers, Washington, DC

(AD-A220624; ITL-90-1) Avail: NTIS HC A04/MF A01 CSCL 12/5

A front-end analysis was conducted to study the possibilities of expanding the use of computers in instruction at the United States Army Command and General Staff College (CGSC). The CGSC is organized in five schools, one of which, Command and General Staff School (CGSS), is not formally established. The schools provide instruction to commissioned and noncommissioned officers and civilians through 4 primary course and approximately 20 short courses. The primary courses are CAS3 (Combined Arms and Services Staff School) Phase 1 Nonresident Course, CAS3 Phase 2 Resident Course, CGSOC (Command and General Staff Officers Course), and SAMS (School of Advanced Military Studies). The shorter courses are primarily provided through SPD (School for Professional Development). This report presents the results of analysis of organization and cognitive level in the primary courses to provide the project team sufficient understanding of the College and enable careful consideration of the application of computers to learning in a subsequent task. Numerous opportunities for the integration of computers into the curricula were identified. This report presents the findings and recommendations of Task A of the front-end analysis. Related reports are separately bound. The reports all have the beginning title, Application of Computers to Learning in the Command and General Staff College. GRA

**N90-23925#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**COMPARISON OF BATCH MEANS AND INDEPENDENT REPLICATIONS TECHNIQUES TO APPLICATIONS OF THE KALMAN FILTER FOR SIMULATION OUTPUT ANALYSIS M.S. Thesis**
Charles H. Porter Mar. 1990 133 p
(AD-A220656; AFIT/GOR/ENS/90M-15) Avail: NTIS HC A07/MF A01 CSCL 20/3

The purpose of this thesis was twofold. First, to develop software which automated the current simulation output analysis techniques of batch means and independent replications. Second, to determine the applicability of employing Kalman filtering for simulation output analysis on an M/M/1 queue. The Output Analysis Program incorporates batch means and independent replications into a menu driven, micro-computer program. The program allows the user to quickly analyze the simulation output graphically, discard the transient, and then perform the two techniques. The Kalman Filter proved valuable in providing insight into the underlying system variance in steady state, and appeared to offer several avenues for further research, particularly in the area of transient identification. GRA

**N90-23926#** Washington Univ., Seattle. Dept. of Computer Science and Engineering.
**GEMINI2: A SECOND GENERATION LAYOUT VALIDATION PROGRAM**
Carl Ebeling Dec. 1989 7 p
(Contract N00014-88-K-0453)
(AD-A220731; NWLIS-89-12-06) Avail: NTIS HC A02/MF A01 CSCL 12/5

Gemini is a circuit comparison program that is widely used to compare circuit layout against a specification. In this paper we describe recent extensions made to Gemini that make it faster, enable it to isolate errors better, and extend its domain of application. This has been done by changes to the labeling algorithm, extensions to the local matching algorithm, better handling of symmetrical circuits and the accommodation of series-connected transistors. Gemini2's algorithm is separated into global labeling and local matching phases. Gemini2 dynamically switches between the two depending on the amount of local structure contained in the circuit, taking advantage of the speed of the local matching algorithm when possible and relying on the power of the more general algorithm when the simple algorithm fails. This blending of algorithms also allows differences between two circuits to be better contained so that defects can be pinpointed. GRA

**N90-23927#** Washington Univ., Seattle. Dept. of Computer Science and Engineering.
**WIRELISP: COMBINING GRAPHICS AND PROCEDURES IN A CIRCUIT SPECIFICATION LANGUAGE**
Carl Ebeling and Zhanbing Wu Dec. 1989 8 p
(Contract N00014-88-K-0453)
(AD-A220740; NWLIS-89-12-07) Avail: NTIS HC A02/MF A01 CSCL 12/5

WireLisp is a language that incorporates both procedural and graphical constructs for describing the structure of complex circuits. This combination provides both the clarity of a graphical representation and the expressiveness of a procedural description. This paper describes how this is done in a conceptually simple way by representing procedural information graphically. WireLisp is built on Lisp which allows the designer to extend the language with arbitrary functions, and allows the incorporation of other kinds of descriptions such as behavioral and physical descriptions. WireLisp is implemented in T Lisp and has been used to describe a complex (130,000 transistor) VLSI chip design. GRA

**N90-23928#** Mission Research Corp., Albuquerque, NM.
**SPHC (SMOOTH PARTICLE HYDRODYNAMICS CODE) MANUAL Final Report, Mar. 1988 - Dec. 1989**
R. Stellingwerf Mar. 1990 100 p
(Contract F29601-86-C-0216; AF Proj. 5797)
(AD-A220743; MRC/ABQ-R-1237; WL-TN-TN-90-04) Avail: NTIS HC A05/MF A01 CSCL 12/5

This document is a manual for the use of the Smooth Particle Hydrodynamics Code (SPHC). This code offers rapid hydrodynamic simulations with no large degradation in simulation accuracy. It has been successfully used to simulate implosions, explosions, shock tubes and to monitor aggregate masses under hydrodynamic conditions. In addition, SPHC can divide, create, and subtract particles in the simulations to optimize results without adversely affecting run conditions. The code is written in the C language and is relatively machine independent. It can be hosted on a variety of computers, ranging from supercomputers to IBM-AT class micro-computers. The SPHC manual has four sections: (1) a User's Guide; (2) a Programmer's Guide; (3) a Technical Guide; and (4) a Function Directory. GRA

**N90-23929#** Space Technology Corp., Fort Collins, CO.
**NOVEL NUMERICAL ALGORITHMS FOR SENSING, DISCRIMINATION, AND CONTROL Final Report**
Michael Andrews 9 Mar. 1990 52 p
(Contract N00014-89-C-0219)
(AD-A220805) Avail: NTIS HC A04/MF A01 CSCL 12/6

This report describes research and development of efficient algorithms and computer architectures for certain Strategic Defense Initiative processing tasks. Spin rate, phase retrieval, and superresolution were analyzed. Efficient mappings of pertinent convolution, Hilbert and Wigner-Ville transforms, and an SVD onto a novel parallel/pipelined architecture were established. An ultrafast E/O interface method to high speed electronic circuits is described. The proposed solution is a fast SIMD/MIND machine capable of teraop speeds, combining multiple 4-PE horizontally micro-programmable nodes onto a mesh-connected organization (fiber-optics). GRA

**N90-23930#** Ohio State Univ., Columbus. Lab. for Artificial Intelligence Research.
**EXPLANATION AND THE THEORY OF EXPERT PROBLEM SOLVING Final Technical Report, Jan. 1985 - Jan. 1989**
B. Chandrasekaran Feb. 1990 431 p
(Contract F30602-85-C-0010; ARPA Order 5309)
(AD-A220861; RADC-TR-89-377) Avail: NTIS HC A19/MF A03 CSCL 12/5

This report summarizes the activities and results of a four-year project that started in the middle of January 1985. This effort concentrated on the development of technology for providing knowledge-based expert planning and problem-solving systems with explanation capabilities. This technology enables such systems to explain and justify their decisions, recommendations, problem solving strategies and use of problem data so that users of such systems can have confidence in the consultations and advice provided by the expert system. GRA

**N90-23931#** Aerospatiale, Paris (France).
**SOFTWARE MAINTENANCE ON AIRBUS FAMILY**
J. Grossin and F. Coustalat 1989 9 p
(Rept-892-111-101; ETN-90-96624) Avail: NTIS HC A02/MF A01

Two technologies used to ease software changes on board the Airbus family are described. On one all computers with a database have teleloading capability from an MDDU (Multipurpose Disk Drive Unit): configuration management is performed through MCDU (Multipurpose Control and Display Unit), teleloading is monitored by the onboard computers. On the other an extensive use of OBRM (On Board Replaceable Module) is made to implement operational program of all computers on which changes are expected. Installation of the modules in the computer builds the part number, solving automatically the configuration control problem; special techniques are used to check compatibility between OBRM's of a given set and between this set and the computer hardware. ESA

**N90-23932#** Technische Univ., Delft (Netherlands). Faculty of Technical Mathematics and Informatics.
**THE LORE-INTERPRETER: NOTES ON THE IMPLEMENTATION**
Bob Goedhart and Willem Jonker 1989 25 p
(Rept-89-60; ISSN-0922-5641; ETN-90-96664) Copyright Avail: NTIS HC A03/MF A01

The implementation of the interpreter of the logic based programming environment LORE is described. The description focuses on the execution of instructions using a dynamic environment implemented by stacks. Execution of instructions, unification and backtracking is explained in terms of these stacks. The item and the instruction segment, unification and matching algorithms, and backtracking are described. The main datastructures, control stack, binding stack and data stack, and the execution of instructions and their effect on these stacks are detailed. Suggestions for improvement are given. ESA

**N90-23933#** Technische Univ., Delft (Netherlands). Faculty of Technical Mathematics and Informatics.
**CONCEPTUAL DEPENDENCY GRAPHS AND DJ**
Afke vanRijn 1989 26 p
(Rept-89-62; ISSN-0922-5641; ETN-90-96666) Copyright Avail: NTIS HC A03/MF A01

Aspects of the language DJ for programming a robot are described. The user input for programming an assembly cell is addressed. The framework, the language DJ and conceptual dependency graphs to represent the program semantics are described. A sketch of how conceptual dependency graphs represent DJ is given and a parser transforms instructions in DJ into conceptual dependency graphs is outlined. The current state of the project is described. ESA

**N90-23934#** Technische Univ., Delft (Netherlands). Faculty of Technical Mathematics and Informatics.
**A SURVEY OF SEARCH DIRECTIONS IN INTERIOR POINT METHODS FOR LINEAR PROGRAMMING**
D. denHertog and C. Roos 1989 39 p
(Rept-89-65; ISSN-0922-5641; ETN-90-96667) Copyright Avail: NTIS HC A03/MF A01

A basic characteristic of an interior point algorithm for linear programming is search direction. Explicit expressions for the search directions used in many well known algorithms are derived. Comparing these explicit expressions give a good insight into the similarity and differences between the various algorithms. A survey of projected gradient and Newton directions for all potential functions, both for the affine and projective variants, is given. ESA

**N90-23935#** Technische Univ., Delft (Netherlands). Faculty of Technical Mathematics and Informatics.
**THE DELFI3-INTERPRETER: NOTES ON THE IMPLEMENTATION**
Bob Goedhart and Willem Jonker 1989 18 p
(Rept-89-72; ISSN-0922-5641; ETN-90-96674) Copyright Avail: NTIS HC A03/MF A01

The implementation of the interpreter of the logic based programming environment Delfi3 is described. Delfi3 is an extension of the logic programming environment LORE. The description focuses on the execution of instructions using a dynamic environment implemented by stacks. Extensions made to LORE are: the record and variant type; a different interpretation of the quote; the assignment; the call for an external program (xrel-call); the ifa-facet; and the brules and frules function. ESA

**N90-23936#** Technische Univ., Delft (Netherlands). Faculty of Technical Mathematics and Informatics.
**A SCANNING ALGORITHM FOR DISPLAY OF GENERALIZED CYLINDERS**
Willem F. Bronsvoort 1989 19 p
(Rept-89-77; ISSN-0922-5641; ETN-90-96679) Copyright Avail: NTIS HC A03/MF A01

A display algorithm for generalized cylinders, objects defined by sweeping an arbitrary two dimensional contour along an arbitrary three dimensional trajectory, while simultaneously scaling the contour in two perpendicular directions, is presented, based on generating successive points on contours positioned at successive points on the trajectory. This scanning algorithm requires that the contours, and also the points on a contour, are taken close enough to guarantee that no gaps occur in the projected surface of the generalized cylinder. On the other hand, for the sake of efficiency, care has to be taken to restrict the number of superfluous points. Solutions for these problems are described and the elegancy and efficiency of a scanning algorithm as a display algorithm for parametrically defined generalized cylinders is shown. ESA

**N90-23937#** Technische Univ., Delft (Netherlands). Theoretical Computer Science Section.
**A TABULAR BOTTOM UP RECOGNIZER**
J. P. M. DeVreught and H. J. Honig 17 Nov. 1989 33 p
(Rept-89-78; ISSN-0922-5641; ETN-90-96680) Copyright Avail: NTIS HC A03/MF A01

Algorithms that can recognize a language in L2 described by a Context Free Grammar (CFG) are addressed. Most algorithms are variants of the Cocke-Younger-Kasami (CYK) algorithm or the Earley algorithm. Both of these are tabular algorithms with space complexity O(n squared) and time complexity O(n cubed). The algorithm given in this paper is also tabular and has complexity bounds. However, it is not a CYK or Earley variant. It has in common with the CYK algorithm that it is easy to parallellize, and with the Earley algorithm that it uses a general CFG instead of a grammar in Chomsky Normal Form (CNF). ESA

**N90-23938#** Technische Univ., Delft (Netherlands). Faculty of Technical Mathematics and Informatics.
**TOOL SUPPORT FOR VDM**
Nico Plat and Hans Toetenel 1989 62 p
(Rept-89-81; ISSN-0922-5641; ETN-90-96682) Copyright Avail: NTIS HC A04/MF A01

An overview of currently available tool support for the formal method for software development VDM (Vienna Development Method) is presented. The tools presented are characterized by the kind of support they offer (syntactic, semantic or pragmatic tools), by the level to which they support the overall life cycle model for software development (integration) and by the specific VDM dialect they support. From the tool enumeration a number of conclusions with regard to possible research in the area of tool development for formal methods are drawn. ESA

**N90-23939#** Technische Univ., Delft (Netherlands). Software Engineering Group.
**SOME ELEMENTARY QUESTIONS ON SOFTWARE QUALITY CONTROL**
Jacco Wesselius 1989 60 p
(Rept-89-83; ISSN-0922-5641; ETN-90-96683) Copyright Avail: NTIS HC A04/MF A01

Quality control in software development is studied. The question of what is meant by quality in software development is addressed. Founded on the answer to this question, the way software is being developed nowadays is scrutinized and the most important topics of future research regarding quality control in software development are named. ESA

**N90-23940#** Technische Univ., Delft (Netherlands). Faculty of Technical Mathematics and Informatics.
**AN O(SQUARE ROOT OF n) COMPLEXITY REDUCTION FOR THE LONG-STEP PATH-FOLLOWING ALGORITHM FOR LINEAR PROGRAMMING**
D. denHertog, C. Roos, and J.-P. Vial 1989 19 p
(Grant FNSRS-1-467-0-86)
(Rept-89-85; ISSN-0922-5641; ETN-90-96685) Copyright Avail: NTIS HC A03/MF A01

A modification of a previously published long-step path following algorithm for the solution of the linear programming is presented. It uses the simple Goldstein-Armijo rule, which enables an O(square

root of n) reduction in the complexity bound to be obtained, while a line search still may be done. ESA

**N90-23941#** Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Numerical Mathematics.
**TESTING OF ELEMENTARY FUNCTIONS IN Ada**
M. Bergman May 1989 47 p
(CWI-NM-R8909; ETN-90-96737) Copyright Avail: NTIS HC A03/MF A01

The elementary mathematical functions, not comprised in the language Ada, are designed and implemented. These basic functions are tested thoroughly. A number of test methods and the tests that are used to examine the elementary functions are described. The results are interpreted in two ways: they are compared with the results of the tests of non-Ada libraries and they are interpreted taking into account the model number arithmetic of Ada. ESA

**N90-23942#** Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Operations Research, Statistics, and System Theory.
**SEQUENCING AND SCHEDULING: ALGORITHMS AND COMPLEXITY**
Eugene L. Lawler, Jan Karel Lenstra, Alexander H. G. RinnooyKan, and David B. Shmoys (Massachusetts Inst. of Tech., Cambridge.) Jun. 1989 73 p Submitted for publication Sponsored in part by Presidential Youth Investigator Award; IBM; Sun Microsystems; and UPS
(Grants AF-AFOSR-0078-86; NSF CCR-87-04184)
(CWI-BS-R8909; ETN-90-96746) Copyright Avail: NTIS HC A04/MF A01

A survey on the area of deterministic machine scheduling is given. Sequencing and scheduling as a research area is motivated by questions arising in production planning, in computing control, and generally in all situations in which scarce resources have to be allocated to activities over time. The work includes a review on complexity results and optimization and approximation algorithms for problems involving a single machine, parallel machines, open shops and jobs shops. Two extensions of this area are also considered: resource-constrained project scheduling and stochastic machine scheduling. ESA

**N90-23943#** Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Operations Research, Statistics, and System Theory.
**SCHEDULING AROUND A SMALL COMMON DUE DATE**
J. A. Hoogeveen and S. L. vandeVelde Jul. 1989 10 p Sponsored by the Netherlands Organization for the Advancement of Research
(CWI-BS-R8914; ETN-90-96751) Copyright Avail: NTIS HC A02/MF A01

A set of n jobs scheduled on a single machine which can handle only one job at a time are presented. Each job requires a given positive uninterrupted processing time and has a positive weight. The problem is to find a schedule that minimizes the sum of weighted deviations of the job completion times from a given common due date d, which is smaller than the sum of the processing times. It is proven that this problem is NP-hard even if all the job weights are equal. A pseudopolynomial algorithm that requires O(n to the 2nd power d) time and O(nd) space is presented. ESA

**N90-23944#** Utrecht State Univ. (Netherlands). Dept. of Computer Science.
**ON LINEAR TIME MINOR TESTS AND DEPTH FIRST SEARCH**
Hans L. Bodlaender Jan. 1989 22 p
(RUU-CS-89-1; ETN-90-96766) Avail: NTIS HC A03/MF A01

An efficient algorithm for testing whether a given graph G contains at least one graph H sub i as a minor is considered. In the present work the following results is discussed: if at least one graph H sub is a minor of a 2xk grid graph, and at least one graph H sub i is a minor of a circus graph, then one can test in O(n) time whether a given graph G contains at least one graph H is a member of (H sub 1,...,H sub c) as a minor. This result generalizes a result of Fellows and Langston. The algorithm is based on depth first search and on dynamic programming on graphs with bounded treewidth. It follows that the maximum leaf spanning tree problem can be solved in linear time for fixed k. Small modifications of Fellows and Langston are discussed. ESA

**N90-23945#** Utrecht State Univ. (Netherlands). Dept. of Computer Science.
**BIT-OPTIMAL ELECTION IN SYNCHRONOUS RINGS**
Hans L. Bodlaender and Gerard Tel Jan. 1990 8 p Sponsored in part by Netherlands Organization for Scientific Research
(RUU-CS-89-2; ETN-90-96767) Avail: NTIS HC A02/MF A01

An election algorithm for synchronous rings with unknown size is presented. The bit complexity of the proposed algorithm is linear in the number of processes. The time complexity is polynomial in the number of processes, but exponential in the smallest identity of any process. The purpose of an election algorithm is to bring the network into a state where one and only one process has the status elected, while all other processes have the status defeated. ESA

**N90-23946#** Stanford Univ., CA. Dept. of Computer Science.
**DEDUCTIVE COMPUTER PROGRAMMING, REVISION Final Report, 1 Aug. 1988 - 30 Sep. 1989**
Zohar Manna 30 Sep. 1989 9 p
(Grant AF-AFOSR-0281-88; AF Proj. 2304)
(AD-A219848; AFOSR-90-0333TR) Avail: NTIS HC A02/MF A01 CSCL 12/5

In an effort to make the research accessible to a wider audience besides the scholarly journals, the PI has published two volumes of the book, The Logical Basis of Computer Programming. This book requires only an intuitive understanding of sets, relations, functions, and numbers. Despite the elementary approach, the text presents some novel research results, including: theories of strings, trees, lists and finite sets which are particulary suited to theorem-proving and program-synthesis applications; formalization of parsing; a nonclausal version of skolemization; a treatment of mathematical induction in the deductive-tableau framework. The implemented tableau system combines features lacking elsewhere such as producing proofs by mathematical inducing. GRA

**N90-23947#** Stanford Univ., CA. Systems Optimization Lab.
**A VECTORIZATION ALGORITHM FOR THE SOLUTION OF LARGE, SPARSE TRIANGULAR SYSTEMS OF EQUATIONS**
Samuel K. Eldersveld and Martin C. Rinard Jan. 1990 17 p Submitted for publication
(Contract N00014-90-J-1242; NSF ECS-87-15153)
(AD-A219850; SU-SOL-90-1) Avail: NTIS HC A03/MF A01 CSCL 12/4

A new method is given for use with vector computers on applications that require multiple solutions with identically patterned triangular factors and different right-hand sides. A key feature is that a vectorization algorithm is used to place the nonzeros from the factors in a few long vectors. The method is shown to work well when incorporated into the mathematical programming system MINOS and tested on 30 linear programming test problems. GRA

**N90-23948#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**AN ABSTRACT DATA MODEL FOR THE IDEF SUB 0 GRAPHICAL ANALYSIS LANGUAGE**
Gerald Roger Morris, Thomas C. Hartrum, and Mark A. Roth 11 Jan. 1990 21 p
(AD-A219855; AFIT/EN-TR-90-1) Avail: NTIS HC A03/MF A01 CSCL 12/5

IDEF sub 0 is the United States Air Force's ICAM (Integrated Computer Aided Manufacturing) Definition Method Zero graphical analysis language, a subset of Ross' Structured Analysis (SA) language. The language is also an excellent methodology for performing a requirements-phase analysis for any software

development project. We present an abstract data model for IDEF sub 0 using entity-relationship diagrams. This model helps to mitigate some of the ambiguities inherent in IDEF sub 0. The model is divided into two parts representing the analysis data (the essential data model) and the graphical data (the drawing data model). This dual modeling approach allows for the extraction of analysis data without having to deal explicitly with the IDEF sub 0 graphical language. GRA

**N90-23949#** California Univ., Berkeley. Electronics Research Lab.
**NUMERICAL OPTIMIZATION, SYSTEM THEORETIC AND SOFTWARE TOOLS FOR THE INTEGRATED DESIGN OF FLEXIBLE STRUCTURES AND THEIR CONTROL SYSTEMS Final Report, 30 Sep. 1986 - 29 Sep. 1989**
Elijah Polak 16 Feb. 1990 10 p
(Grant AF-AFOSR-0116-86; AF Proj. 2304)
(AD-A219877; AFOSR-90-0339TR) Avail: NTIS HC A02/MF A01 CSCL 12/5

The research covered by this report was aimed at developing a broad, optimization-based methodology for use in computer-aided-design of engineering systems. To this end, research was carried out in the following areas: (1) the development of a theory which can be used as a general guide in the construction of semi-infinite optimization, shape optimization and optimal control algorithms; (2) the development of various new semi-infinite optimization and optimal control algorithms; (3) the development of techniques for formulating system stability and worst-case requirements as well-conditioned semi-infinite inequalities; (4) the exploration of the use of optimization in the design of control systems; and finally, (5) interactive software for optimization-based control system design. GRA

**N90-23950#** Massachusetts Inst. of Tech., Cambridge. Lab. for Computer Science.
**SHARING MEMORY ROBUSTLY IN MESSAGE-PASSING SYSTEMS Technical Report**
Hagit Attiya, Amotz Bar-Noy, and Danny Dolev (IBM Research Lab., San Jose, CA.) 16 Feb. 1990 27 p Sponsored in part by Weizmann Fellowship, Stanford Univ., CA, and by Hebrew Univ., Jerusalem, Israel
(Contracts N00014-85-K-0168; N00014-83-K-0125; N00014-88-K-0166; N00014-89-J-1988; NSF CCR-86-11442)
(AD-A219923; MIT/LCS/TM-423) Avail: NTIS HC A03/MF A01 CSCL 12/7

Emulators that translate algorithms from the shared-memory model to two different message-passing models are presented. Both are achieved by implementing a wait-free, atomic, single-writer multi-reader register in unreliable, asynchronous networks. The two message-passing models considered are a complete network with processor failures and an arbitrary network with dynamic link failures. These results make it possible to view the shared-memory model as a higher-level language for designing algorithms in asynchronous distributed systems. Any wait-free algorithm based on atomic, single-writer multi-reader registers can be automatically emulated in message-passing systems. The overhead introduced by these emulations is polynomial in the number of processors in the systems. Immediate new results are obtained by applying the emulators to known shared-memory algorithms. These include, among others, protocols to solve the following problems in the message-passing model in the presence of processor or link failures: multi-writer multi-reader registers, concurrent time stamp systems, l-exclusion, atomic snapshots, randomized consensus, and implementation of a class of data structures. GRA

**N90-23951#** Massachusetts Inst. of Tech., Cambridge. Artificial Intelligence Lab.
**NATURAL LANGUAGE SYNTAX AND FIRST ORDER INFERENCE**
David McAllester and Robert Givan Oct. 1989 29 p
(Contract N00014-86-K-0180; NSF IRI-88-19624)
(AD-A219944; AIM-1176) Avail: NTIS HC A03/MF A01 CSCL 05/7

First order inference can be made more efficient by using non-standard syntax for first order logic. This paper shows how a fragment of English syntax under Montague semantics provides the foundation of a new inference procedure. This procedure seems more effective than corresponding procedures based on either classical syntax or our previously proposed taxonomic syntax. This observation may provide a functional explanation for some of the syntactic structure of English. GRA

**N90-23952#** Massachusetts Inst. of Tech., Cambridge. Artificial Intelligence Lab.
**OPTIMIZATION OF SERIES EXPRESSIONS. PART 2: OVER VIEW OF THE THEORY AND IMPLEMENTATION**
Richard C. Waters Dec. 1989 51 p Submitted for publication Sponsored in part by IBM and NYNEX Corp.
(Contract N00014-88-K-0487; NSF IRI-86-16644)
(AD-A219961; AI-M-1083) Avail: NTIS HC A04/MF A01 CSCL 12/5

The benefits of programming in a functional style are well known. In particular, algorithms that are expressed as compositions of functions operating on sequences/vectors/streams of data elements are easier to understand and modify than equivalent algorithms expressed as loops. Unfortunately, this kind of expression is not used anywhere near as often as it could be, for at least three reasons: most programmers are less familiar with this kind of expression than with loops; most programming languages provide poor support for this kind of expression; and when support is provided, it is seldom efficient. In many programming languages, the second and third problems can be largely solved by introducing a data type called series, a comprehensive set of procedures operating on series, and a preprocessor (or compiler extension) that automatically converts most series expressions into efficient loops. A set of restrictions specifies which series expressions can be optimized. If programmers stay within the limits imposed, they are guaranteed of high efficiency at all times. A Common Lisp macro package supporting series has been in use for some time. A prototype demonstrates that series can be straightforwardly supported in Pascal. GRA

**N90-23953#** Dayton Univ., OH.
**SHAPE DISCRIMINATION RESEARCH USING AN IBM PC Final Technical Report, Oct. 1987 - Jul. 1989**
Christopher D. Voltz and George A. Geri Mar. 1990 83 p
(Contract F33615-87-C-0012; AF Proj. 2313; AF Proj. 1123)
(AD-A219993; AFHRL-TR-89-42) Avail: NTIS HC A05/MF A01 CSCL 12/5

A menu-driven program is described that is designed to control the presentation of visual stimuli and to collect and analyze response data in shape discrimination research. The program presents high resolution stimuli on an IBM PC equipped with an IBM Professional Graphics Adaptor (PGA) and an analog monitor. Bit-plane layering is employed to allow multiple test and adapting stimuli (1- to 2-bit gray scale) to be presented with specifiable interstimulus intervals. The program implements a double-random staircase paradigm, collects a subject's responses via the computer's parallel port, and analyzes the resulting data. In addition, auxiliary programs are provided for generating Fourier Descriptor shape stimuli, for modifying stimulus parameters, and for formatting and storing the final stimuli for use by the main program. GRA

**N90-23954#** Royal Signals and Radar Establishment, Malvern (England). Speech Research Unit.
**IMPROVING UPON STANDARD PATTERN CLASSIFICATION ALGORITHMS BY IMPLEMENTING THEM AS MULTI-LAYER PERCEPTRONS**
Mark D. Bedworth 12 Dec. 1989 26 p
(AD-A220046; RSRE-Memo-4346; DRIC-BR-112834) Avail: NTIS HC A03/MF A01 CSCL 12/9

The multi-layer perceptron (MLP) is a type of adaptive layered network often used as a pattern classifier. In more recent literature, MLPs are compared with simpler classification techniques using common datasets. We select two of these simple static pattern

classification algorithms and briefly review the relevant techniques. After introducing a modest set of evaluation databases, the performance of the standard classifiers and MLPs are assessed. A technique for implementing the two standard classifiers as MLPs is presented and this novel approach is used to automatically design a good set of initial weights for the MLP networks. Encouraging experimental results for these hybrid techniques are shown for illustration. GRA

**N90-23955#** Naval Postgraduate School, Monterey, CA. Dept. of Physics.
**A PC-BASED IMAGING SYSTEM FOR THE NAVAL POSTGRADUATE SCHOOL INFRARED SEARCH AND TARGET DESIGNATION (NPS-IRSTD) SYSTEM M.S. Thesis**
Raymond Charles Engel Sep. 1989 148 p
(AD-A220109) Avail: NTIS HC A07/MF A01 CSCL 17/5

A system to display images from data generated by the Naval Postgraduate School Infrared Search and Target Designation (NPS-IRSTD) system (modified AN/SAR-8 ADM) was developed using an Intel 80386 CPU based desktop computer as the base platform. This computer was enhanced with a Metrabyte PDMA-16 Input/Output board to facilitate data transfers and a Data Translation DT2861 framegrabber board for image processing. Images are displayed on a 512 by 480 pixel resolution color monitor. Digitized NPS-IRSTD data is stored on recording tape, and accessed for imaging during playback at reduced speeds. Data is received into the 386 computer through the PDMA-16 using Direct Memory Access (DMA) transfers into Random Access Memory (RAM). Data is sorted in RAM into the proper format for display, and then moved to a frame buffer in the DT2861. FORTRAN programs using Data Translation DT-IRIS subroutines were written to manage image display and processing. Images produced using the system showed clearly identifiable features from the scene observed by the IRSTD. They also provided valuable insight into the IRSTD operation. For example, the detector ac-coupling undershoot was clearly evident. Additionally, images showed the number of non-operational detectors to be larger than previously noted. GRA

**N90-23956#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**A COMPARISON OF A RELATIONAL AND NESTED-RELATIONAL IDEF0 DATA MODEL M.S. Thesis**
Gerald Roger Morris Mar. 1990 187 p
(AD-A220147; AFIT/GCE/ENG/90M-2) Avail: NTIS HC A09/MF A01 CSCL 12/5

An abstract data model is developed for a particular computer aided software engineering (CASE) methodology, and compares the query complexity, database size, and speed of query execution of a relational database management system (DBMS) implementation of the methodology with a nested-relational DBMS implementation of the same CASE methodology. In particular, the United States Air Force Integrated Computer Aided Manufacturing (ICAM) program's subset of Ross's Structured Analysis (SA) language called ICAM Definition Method Zero (IDEF0) is considered. Ingres Corporation's relational DBMS, Ingres, is the implementation media for the relational version. The University of Wisconsin's extensible database, Exodus, is the implementation media for the nested-relational version. Background information is provided on the development of CASE methodologies and the development of database management systems. Additionally, it provides an overview of the IDEF0 analysis language, and the Exodus extensible DBMS. GRA

**N90-23957*#** Wyle Labs., Inc., Huntsville, AL.
**DATA QUALITY ANALYSIS AT THE NATIONAL TRANSONIC FACILITY**
Pamela N. Stewart Washington NASA Jul. 1990 29 p
(Contract NAS1-18304)
(NASA-CR-4303; NAS 1.26:4303) Avail: NTIS HC A03/MF A01 CSCL 09B

The data quality analysis program that was developed at Langley Research Center's National Transonic Facility is described. The program provides a computer driven systematic analysis of data taken during calibrations of the high speed digital data acquisition system. Five distinct checks that are performed on the calibration data are outlined. The five checks are for non-linearity, noise, short term drift, long term drift, and the proper functioning of the calibrator. The program has established a standard set of evaluation guidelines. Author

**N90-23958*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**AN EXPERIMENTAL EVALUATION OF SOFTWARE REDUNDANCY AS A STRATEGY FOR IMPROVING RELIABILITY**
Dave E. Eckhardt, Jr., Alper K. Caglayan, John C. Knight, Larry D. Lee, David F. McAllister, Mladen A. Vouk, and John P. J. Kelly (California Univ., Santa Barbara.) May 1990 24 p
(NASA-TM-102613; NAS 1.15:102613) Avail: NTIS HC A03/MF A01 CSCL 09B

The strategy of using multiple versions of independently developed software as a means to tolerate residual software design faults is suggested by the success of hardware redundancy for tolerating hardware failures. Although, as generally accepted, the independence of hardware failures resulting from physical wearout can lead to substantial increases in reliability for redundant hardware structures, a similar conclusion is not immediate for software. The degree to which design faults are manifested as independent failures determines the effectiveness of redundancy as a method for improving software reliability. Interest in multi-version software centers on whether it provides an adequate measure of increased reliability to warrant its use in critical applications. The effectiveness of multi-version software is studied by comparing estimates of the failure probabilities of these systems with the failure probabilities of single versions. The estimates are obtained under a model of dependent failures and compared with estimates obtained when failures are assumed to be independent. The experimental results are based on twenty versions of an aerospace application developed and certified by sixty programmers from four universities. Descriptions of the application, development and certification processes, and operational evaluation are given together with an analysis of the twenty versions. Author

**N90-23959*#** Illinois Univ., Urbana-Champaign. Center for Reliable and High Performance Computing.
**A PARALLEL ALGORITHM FOR GLOBAL ROUTING**
Randall J. Brouwer and Prithviraj Banerjee 26 Jun. 1990 22 p
(Grant NAG1-613)
(NASA-CR-186152; NAS 1.26:186152) Avail: NTIS HC A03/MF A01 CSCL 09B

A Parallel Hierarchical algorithm for Global Routing (PHIGURE) is presented. The router is based on the work of Burstein and Pelavin, but has many extensions for general global routing and parallel execution. Main features of the algorithm include structured hierarchical decomposition into separate independent tasks which are suitable for parallel execution and adaptive simplex solution for adding feedthroughs and adjusting channel heights for row-based layout. Alternative decomposition methods and the various levels of parallelism available in the algorithm are examined closely. The algorithm is described and results are presented for a shared-memory multiprocessor implementation. Author

**N90-23960#** Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Software Technology.
**A PROCESS SPECIFICATION FORMALISM BASED ON STATIC COLD**
J. C. M. Baeten, J. A. Bergstra, S. Mauw, and G. J. Veltink (Amsterdam Univ., Netherlands ) Aug. 1989 51 p Sponsored in part by EEC
(CWI-CS-R8930; ETN-90-96801) Copyright Avail: NTIS HC A04/MF A01

The construction of a language PSF/C is described. PSF/C is a formal specification language based on COLD, a wide spectrum specification language. In PSF/C, concurrent communicating processes can be specified. The process syntax and semantics

are based on the algebraic concurrency language ACP. The design objectives are listed and were achieved. Remarks on the implementation are included. ESA

**N90-23961#** Universiteit Twente, Enschede (Netherlands). Faculty of Applied Mathematics.
**COLORING A GRAPH OPTIMALLY WITH TWO COLORS**
H. J. Broersma and F. Goebel Nov. 1989 14 p
(MEMO-820; ISSN-0169-2690; ETN-90-96825) Avail: NTIS HC A03/MF A01

In the study the following parameters are set: let g be a graph with point set V; a coloring of G is a map of V to the set (red, white). An error occurs whenever the two endpoints of a line have the same color. An optimal coloring of G is a coloring of G for which the number of errors is minimum. The minimal number of errors is denoted by gamma(G). Among other things, the maximum gamma asterisk (n,m) of gamma(G) over all G with n points and m lines is investigated. ESA

**N90-23962#** Universiteit Twente, Enschede (Netherlands). Faculty of Applied Mathematics.
**CALCULATION OF LIE ALGEBRA COHOMOLOGY BY COMPUTER**
N. W. vandenHijligenberg and G. F. Post Dec. 1989 39 p
(MEMO-833; ISSN-0169-2690; ETN-90-96838) Avail: NTIS HC A03/MF A01

Computer programs to calculate homology and cohomology of Lie algebras are described. The definition of Lie algebra homology and cohomology, using elementary notions like Lie algebra, the exterior algebra and modules, is given. Representation of abstract objects is shown. Programs written in REDUCE 3 are described and examples are given. The explicit calculation of two cohomology classes using these programs is shown. ESA

**N90-23963#** Universiteit Twente, Enschede (Netherlands). Faculty of Applied Mathematics.
**COMPOUND SETS IN MATHEMATICAL PROGRAMMING MODELING LANGUAGES**
J. J. Bisschop and C. A. C. Kuip Dec. 1989 39 p
(MEMO-834; ISSN-0169-2690; ETN-90-96839) Avail: NTIS HC A03/MF A01

The concept of a compound index set used in modeling languages for mathematical programming is extended to include tuples of different type. In this extension the role of an index is made an explicit part of the mathematical notation. This allows for irregular structures in both data definitions and model constraints. Examples are used throughout to illustrate these structures. The proposed notation is compared to existing notation in terms of the ability to understand, maintain and verify model descriptions. ESA

**N90-23964#** Universiteit Twente, Enschede (Netherlands). Tele-Informatics Group.
**A FORMAL APPROACH TO CONFORMANCE TESTING**
Ed Brinksma, Rudie Alderen, Rom Langerak, Jan Tretmans, and Jereon vandeLagemaat Nov. 1989 20 p Sponsored in part by EEC and Netherlands Ministry of Education
(Memo-INF-89-45; ISSN-0923-1714; ETN-90-96842) Avail: NTIS HC A03/MF A01

A formal framework for the study of questions that are related to the conformance testing of open systems is proposed. This framework allows the methods of conformance testing to be related to the formal specifications of the Implementations Under Test (IUT), and the semantic models on which the Formal Description Techniques (FDT) used are based. A general framework for a theory of conformance testing is proposed on the basis of very limited assumptions on the FDT used. Within this framework formalizations of important concepts such as test suite, test case, test derivation, test coverage, etc., are given and elaborated in examples. Exploiting the link provided by our formal framework, the main theoretical results of the testing theory of labeled transition systems are summarized. The conformance problem specifically in the context of the FDT LOTOS is discussed. ESA

**N90-23965#** Universiteit Twente, Enschede (Netherlands). Tele-Informatics Group.
**SPECIFICATION MODULES IN LOTOS**
Ed Brinksma Nov. 1989 17 p Sponsored in part by EEC and Netherlands Ministry of Education and Sciences
(Memo-INF-89-46; ISSN-0923-1714; ETN-90-96843) Avail: NTIS HC A03/MF A01

The definition of standard LOTOS provides language features that enable a hierarchical organization of specifications, but does not allow a specification to be composed of modules, i.e., of different, self-standing documents. The interface between the static data type parts and the dynamic behavioral parts of a specification has a few undesirable aspects. A way of introducing specification modules in LOTOS that is essentially compatible with the existing features for hierarchical specification is proposed. At the same time it provides a more flexible interface between the static and the dynamic aspects of a specification. ESA

**N90-23966#** Utrecht State Univ. (Netherlands). Dept. of Computer Science.
**ON AXIOMATIZATIONS FOR PROPOSITIONAL LOGICS OF PROGRAMS**
P. M. W. Knijnenburg Nov. 1988 57 p
(RUU-CS-88-34; ETN-90-96856) Avail: NTIS HC A04/MF A01

Different logics of programs systems used in analyzing the behavior of computer programs are reviewed. Attention is focused on a propositional program logic named Proposition Dynamic Logic or PDL. The syntax and semantics of the logic are described. Application of PDL with concurrency is discussed. A universal model theorem for Kripke structures is described. Applications of the PDL with repeat to computational trees and bisimulation are discussed. PDL applied to context-free programs is reviewed. ESA

**N90-23967#** Utrecht State Univ. (Netherlands). Dept. of Computer Science.
**FINDING MINIMUM AREA k-GONS**
Mark H. Overmars, Guenter Rote, and Gerhard Woeginger (Freie Univ., Berlin, Germany, F.R. ) Mar. 1989 18 p
(RUU-CS-89-7; ETN-90-96862) Avail: NTIS HC A03/MF A01

Given a set P of n points in the plane and a number k, a polygon C with vertices in P of minimum area is sought. It must satisfy one of the following properties: C is a convex k-gon, C is an empty convex k-gon, C is the convex hull of exactly k points of P. Algorithms for solving each of these three problems in time O(k(n cubed)) are presented. The algorithms are based on a dynamic programming approach. This approach is generalized to polygons with many other properties, in similar time bounds. ESA

**N90-23968#** Utrecht State Univ. (Netherlands). Dept. of Computer Science.
**COMPUTATIONAL GEOMETRY AND ITS APPLICATION TO COMPUTER GRAPHICS**
Mark H. Overmars Mar. 1989 35 p
(RUU-CS-89-8; ETN-90-96863) Avail: NTIS HC A03/MF A01

Problems concerning shapes of sets of objects are discussed. Particular attention is given to the problem of determining the convex hull of a set of points. A number of different algorithms for this problem are given using different algorithmic techniques. Triangulating point sets and polygons is considered. Proximity problems in which distance plays an important role are discussed. The Voronoi diagram is introduced. It is a powerful structure that stores distance information and uses it to solve the nearest neighbor searching problem. Some point location techniques are used to obtain this solution. The technique is applied to a variety of other problems. ESA

**N90-23969#** Nijmegen Univ. (Netherlands). Dept. of Informatics.
**DESIGNING DISTRIBUTED ALGORITHMS BY MEANS OF FORMAL SEQUENTIALLY PHASED REASONING**

F. A. Stomp and W. P. deRoever (Technische Univ., Eindhoven, Netherlands ) Apr. 1989 32 p
(TR-89-8; ETN-90-96881) Avail: NTIS HC A03/MF A01

A design principle that formally describes how to develop algorithms according to sequentially phased explanations is presented. The design principle is formulated using Manna and Pnueli's linear time temporal logic. This technique, along with Chandy and Misra's technique for designing parallel algorithms, is applicable to large classes of algorithms such as those for minimum-path, connectivity, network flow, and minimum-weight spanning trees. The distributed minimum-weight spanning tree algorithm of Gallager, Humblet, and Spira is structured according to this principle. ESA

**N90-23970#** Nijmegen Univ. (Netherlands). Dept. of Informatics.
**A FORMAL MECHANISM FOR DETERMINING REDUNDANCY AND IRRELEVANCE IN HYPERTEXT VIEWS**
P. D. Bruza May 1989 19 p
(TR-89-9; ETN-90-96882) Avail: NTIS HC A03/MF A01

A citical analysis of Hypertext views is presented. The definition of a view is given. The properties of redundancy and irrelevance with which the views can be judged are defined. A formal model in which Hypertext views can be examined quantitatively on the basis of these properties is described. Access mechanisms for nodes which are better than the present key word approach are presented. The notions of cohesion and of relevance are quantified within the formal framework developed. The possibility of using trigrams or index expressions as an access mechanism for nodes is introduced. ESA

**N90-23971#** Nijmegen Univ. (Netherlands). Dept. of Informatics.
**INVERTING THE FLOW OF COMPUTATION**
E. A. Boiten Jun. 1989 56 p
(Grant NF-63/62-518)
(TR-89-10; ETN-90-96883) Avail: NTIS HC A04/MF A01

A collection of transformation rules and transformation strategies that invert the flow of computation in recursive functions is presented. Previous results of Cohen and Pettorossi are generalized and unified in a hierarchical approach. All the transformation rules presented result in functions that use the arguments of the original function in an inverted order. The efficiency is mainly evaluated with respect to execution time. It is shown that many straightforward recursive solutions to problems suffer from inefficiency. ESA

**N90-23972#** Nijmegen Univ. (Netherlands). Dept. of Informatics.
**FORMAL METHODS IN KNOWLEDGE REPRESENTATION**
J.-J. Ch. Meyer Jun. 1989 13 p Presented at the 25th Dutch Mathematical Congress Symposium on Mathematics and the Computer
(TR-89-11; ETN-90-96884) Avail: NTIS HC A03/MF A01

A concise survey of formal methods of knowledge representation in computer science is presented. Various more or less well known methods are discussed. Particular attention is given to the use of epistemic logic and the area of nonmonotonic methods of reasoning. Formal methods of knowledge representation are contrasted with human reasoning which often contains steps that have a certain degree of uncertainty and which is expressed in natural language open to semantic complexities. Attempts by artificial intelligence researchers to develop more formal languages such as propositional or predicate logic are described. ESA

**N90-23973#** Nijmegen Univ. (Netherlands). Dept. of Informatics.
**THE SEMANTICS OF TRIDL Thesis**
P. D. Bruza and T. P. vanderWeide Sep. 1989 44 p
(TR-89-17; ETN-90-96888) Avail: NTIS HC A03/MF A01

The formal specifications of the TRIDL computer language are presented. The language has its origins in the RIDL language. RIDL is based on a conceptual model. TRIDL is an extension of RIDL giving special attention to time aspects. The T in TRIDL stands for time. The specifications of the TRIDL and RIDL languages discussed include: specifications of a set of objects, specifications of a set of relationships, value and set expressions, time operators, and imperative constructs (if-then-else etc.). Semantics of the target language and examples of proofs of the correctness of TRIDL programs are presented. ESA

**N90-23974#** Nijmegen Univ. (Netherlands). Dept. of Informatics.
**CONCURRENT CLEAN**
M. C. J. D. vanEekelen, E. G. J. M. H. Nocker, M. J. Plasmeijer, and J. E. W. Smestsers Oct. 1989 60 p
(TR-89-18; ETN-90-96889) Avail: NTIS HC A04/MF A01

Concurrent Clean, a lazy functional computer language, is described. Clean is based on Parallel Functional Graph Rewriting systems (PFGR's) such that the notion of sharing of computation and the notion of processes are explicitely present in the language instead of being an option for the implementation. These notions are added to the language to give the programmer the possibility to control the evaluation order which can be used to explicitly influence the time and space behavior of the program where needed. Applications of the software to different computer systems are presented. ESA

# 62 COMPUTER SYSTEMS

Includes computer networks and special application computer systems.

**N90-23975** Georgia Inst. of Tech., Atlanta.
**DESIGN OF FINITE ELEMENT SYSTEMS FOR PARALLEL COMPUTERS Ph.D. Thesis**
Ralph Dietmar Goehlich 1989 200 p
Avail: Univ. Microfilms Order No. DA8925453

A synthesis is provided for parallel processing and finite element methods (FEM) considering both vector and multiprocessing computer architectures. Parallel processing will provide effective computing speeds needed for future large-scale analyses. The key to achieving improved performance on this new class of computers is the development of software designs tailored to parallel computing. The focus is on structural analysis. New parallel procedures and software designs were developed for linear and nonlinear static FEM solutions. Vectorized program designs for element stiffness computations and the generation of nonlinear nodal force vectors were investigated. Two conceptually different approaches were identified: single element and multiple element vectorization. A completely revised software architecture for linear static analysis is proposed which consists of six parallel program modules. Most of the applied parallel procedures are free of interprocess communication and processor load balancing is assured with self-scheduling loops. Two key modules, matrix decomposition and displacement solution, involve substantial synchronization. For these procedures an in-depth performance study was performed which included the implementation of the parallel matrix decomposition module in a production finite element method system. A new parallel program design is presented for nonlinear static analysis. The basic approach is similar as in the linear case and above multiprocessing modules are incorporated in the nonlinear solution sequence. Two additional modules are proposed for the parallel computation of nodal element forces and a parallel Quasi-Newton algorithm. The multiprocessing performance is evaluated. Dissert. Abstr.

**N90-23976*#** Research Inst. for Advanced Computer Science, Moffett Field, CA.
**DISTRIBUTED USER SERVICES FOR SUPERCOMPUTERS**
Henry A. Sowizral 1 Apr. 1989 22 p
(Contract NCC2-387)
(NASA-CR-180370; NAS 1.26:180370; RIACS-TR-89.18) Avail: NTIS HC A03/MF A01 CSCL 09B

User-service operations at supercomputer facilities are examined. The question is whether a single, possibly distributed, user-services organization could be shared by NASA's supercomputer sites in support of a diverse, geographically dispersed, user community. A possible structure for such an organization is identified as well as some of the technologies needed in operating such an organization. Author

**N90-23977*#** Institute for Computer Applications in Science and Engineering, Hampton, VA.
**A NETWORK FLOW MODEL FOR LOAD BALANCING IN CIRCUIT-SWITCHED MULTICOMPUTERS Final Report**
Shahid H. Bokhari (University of Engineering and Technology, Lahore, Pakistan ) May 1990 32 p Submitted for publication
(Contract NAS1-18605)
(NASA-CR-182049; NAS 1.26:182049; ICASE-90-38) Avail: NTIS HC A03/MF A01 CSCL 09B

In multicomputers that utilize circuit switching or wormhole routing, communication overhead depends largely on link contention - the variation due to distance between nodes is negligible. This has a major impact on the load balancing problem. In this case, there are some nodes with excess load (sources) and others with deficit load (sinks) and it is required to find a matching of sources to sinks that avoids contention. The problem is made complex by the hardwired routing on currently available machines: the user can control only which nodes communicate but not how the messages are routed. Network flow models of message flow in the mesh and the hypercube were developed to solve this problem. The crucial property of these models is the correspondence between minimum cost flows and correctly routed messages. To solve a given load balancing problem, a minimum cost flow algorithm is applied to the network. This permits one to determine efficiently a maximum contention free matching of sources to sinks which, in turn, tells one how much of the given imbalance can be eliminated without contention. Author

**N90-23978#** Stanford Univ., CA. Dept. of Computer Science.
**PARALLEL EXECUTION OF LISP PROGRAMS Ph.D. Thesis**
Joseph Simon Weening Jun. 1989 95 p Sponsored by NSF and Hertz (Fannie and John) Foundation
(Contract N00039-84-C-0211)
(AD-A219623; SU-STAN-CS-89-1265) Avail: NTIS HC A05/MF A01 CSCL 12/5

Several issues in the execution of LISP programs on shared memory multiprocessors are considered. An overview of constructs for explicit parallelism in LISP is first presented. The problem of partitioning a program into process and scheduling these processes are then described, and a number of methods for performing these are proposed. These include cutting off process creation based on properties of the computation tree of the program, and basing partitioning decisions on the state of the system at runtime instead of the program. An experimental study of these methods was performed using a simulator for parallel LISP. This is followed by a description of the experiments that were performed and an analysis of the results. Two programs are used as illustrations: a Fast Fourier Transform, which has an abundance of parallelism; and the Cocke-Younger-Kasami parsing algorithm, for which good speedup is not as easy to obtain. The difficulty of using cutoff-based partitioning methods, and the differences between varios scheduling methods, are shown. A combination of partitioning and scheduling methods which is called dynamic partitioning is analyzed in more detail. This method is based on examining the machine's runtime state; it requires that the programmer only identify parallelism in the program, without deciding which potential parallelism is actually useful. It is concluded that for programs whose computational trees have small height relative to their total size, dynamic partitioning can achieve asymptotically minimal overhead in the cost of process creation. GRA

**N90-23979#** Naval Postgraduate School, Monterey, CA. Dept. of Administrative Sciences.
**THE DESIGN OF A LOCAL AREA NETWORK CONFIGURATION MANAGEMENT SYSTEM FOR THE NAVAL POSTGRADUATE SCHOOL ADMINISTRATIVE SCIENCES DEPARTMENT M.S. Thesis**
Douglas A. Suriano Sep. 1989 16 p
(AD-A219643) Avail: NTIS HC A03/MF A01 CSCL 12/7

System requirements are identified and an application system design is provided for an automated Local Area Network (LAN) Configuration Management System to be used by the Naval Postgraduate School Administrative Sciences Department LAN Staff. The proposed system will provide a tool to assist the LAN Staff in carrying out maintenance functions such as tracking changes to the hardware and software configuration of LANs. Problem definition, requirements definition, and system design are among issues addressed. This system is intended for use on a microcomputer based database management system. GRA

**N90-23980*#** Illinois Univ., Urbana-Champaign. Coordinated Science Lab.
**FAILURE ANALYSIS AND MODELING OF A MULTICOMPUTER SYSTEM M.S. Thesis**
Sujatha Srinivasan Subramani Feb. 1990 45 p
(Contracts NCA2-184; NCA2-301; N00014-84-C-0149)
(NASA-CR-186697; NAS 1.26:186697; AD-A219653; UILU-ENG-90-2206; CSG-120) Avail: NTIS HC A03/MF A01 CSCL 09/2

This thesis describes the results of an extensive measurement-based analysis of real error data collected from a 7-machine DEC VaxCluster multicomputer system. In addition to evaluating basic system error and failure characteristics, we develop reward models to analyze the impact of failures and errors on the system. The results show that, although 98 percent of errors in the shared resources recover, they result in 48 percent of all system failures. The analysis of rewards shows that the expected reward rate for the VaxCluster decreases to 0.5 in 100 days for a 3 out of 7 model, which is well over a 100 times that for a 7-out-of-7 model. A comparison of the reward rates for a range of k-out-of-n models indicates that the maximum increase in reward rate (0.25) occurs in going from the 6-out-of-7 model to the 5-out-of-7 model. The analysis also shows that software errors have the lowest reward (0.2 vs. 0.91 for network errors). The large loss in reward rate for software errors is due to the fact that a large proportion (94 percent) of software errors lead to failure. In comparison, the high reward rate for network errors is due to fast recovery from a majority of these errors (median recovery duration is 0 seconds). GRA

**N90-23981#** Yale Univ., New Haven, CT. Dept. of Computer Science.
**THE WAKEUP PROBLEM**
Michael J. Fischer, Shlomo Moran, Steven Rudich (Carnegie-Mellon Univ., Pittsburgh, PA.), and Gadi Taubenfeld Mar. 1990 14 p Presented at the 22nd Annual Symposium on Theory of Computing, Baltimore, MD, May 1990 Sponsored in part by Hebrew Technical Inst.; Technion - Israel Inst. of Tech., Haifa; and Israel Academy of Sciences and Humanities, Jerusalem
(Contract N00014-89-J-1980; NSF CCR-84-05478)
(AD-A220534; YALEU/DCS/TR-771) Avail: NTIS HC A03/MF A01 CSCL 12/5

We study a new problem, the wakeup problem that seems to be very fundamental in distributed computating. We present efficient solutions to the problem, and show how these solution can be used to solve the consensus problem, the leader election problem, and other related problems. The main question we try to answer is, how much memory is needed to solve the wakeup problem. We assume a model that captures important properties of real systems that have been largely ignored by previous work on cooperative problems. GRA

**N90-23982#** Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Numerical Mathematics.
**BLOCK RUNGE-KUTTA METHODS ON PARALLEL COMPUTERS**
P. J. vanderHouwen and B. P. Sommeijer Mar. 1989 19 p
(CWI-NM-R8906; ETN-90-96734) Copyright Avail: NTIS HC A03/MF A01

Block methods for solving ordinary differential equations on parallel computers are constructed. Most block methods found in the literature produce approximations to exact solution at equidistant points. Here, the approximations correspond to nonequidistant points like the intermediate approximations computed in Runge-Kutta methods. This approach enables the order of accuracy to be improved. Explicit methods situable for use on parallel computers are considered. ESA

**N90-23983#** Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Numerical Mathematics.
**BLOCK RUNGE-KUTTA METHODS**
P. J. vanderHouwen Jun. 1989 17 p
(CWI-NM-R8913; ETN-90-96740) Copyright Avail: NTIS HC A03/MF A01

Block methods for solving ordinary differential equations on parallel computers are constructed. Most block methods found in the literature produce approximations to the exact solution at equidistant points. Here the approximations correspond to nonequidistant points like the intermediate approximations computed in Runge-Kutta methods. This approach enables improving the order of accuracy. Explicit methods, suitable for use on parallel computers, are considered. ESA

**N90-23984#** Universiteit Twente, Enschede (Netherlands). Dept. of Computer Science.
**SYMBOLIC REASONING IN MODEL-BASED DIAGNOSIS: EFFICIENT AND EFFECTIVE INFORMATION PROCESSING**
Rene R. Bakker Nov. 1989 21 p
(Memo-INF-89-03; UT-KBS-89-08; ISSN-0923-1714; ETN-90-96753) Avail: NTIS HC A03/MF A01

A method, called symbolic constraint propagation, that computes potential conflicts in advance is described. When measurements become available, the actual conflicts are computed by subsitition, hence no search is necessary. As a result, each conflict is calculated only once. The methods always use all information available in the model. In those cases, the diagnoses may be too broad. Symbolic constaint satisfaction uses more information in the model. It is shown that using symbolic constraint satisfaction may lead to more precise diagnoses. Symbolic constraint propagation and symbolic constraint satisfaction can be combined. The resulting method, called symbolic reasoning, improves the efficiency and effectiveness of current model-based reasoning methods. ESA

**N90-23985#** Universiteit Twente, Enschede (Netherlands). Vakgroep Tele-Informatica.
**ISDN IN THE LOCAL ENVIRONMENT: THE CISLAN PROJECT**
I. G. Niemegeers and J. M. A. Daemen Dec. 1989 20 p
(Memo-INF-89-70; Rept-075-IR-8936; ISSN-0923-1714; ETN-90-96756) Avail: NTIS HC A03/MF A01

A general concept for a future local integrated communication infrastructure is presented. Such an infrastructure can be based on a highly distributed architecture. To explore these concepts a research project was started. The first phase of this project is discussed. A prototype of a system providing an Integrate Services Digital Network (ISDN) bearer service based on an Institute of Electrical and Electronics Engineers P802.5 local area network is presented. A hybrid switching technique is used whereby the service to voice traffic is unaffected by the data traffic. ESA

**N90-23986#** Utrecht State Univ. (Netherlands). Dept. of Computer Science.
**DISTRIBUTED HIERARCHICAL ROUTING**
P. J. A. Lentfert, A. H. Uittenbogaard, S. D. Swierstra, and Gerard Tel Mar. 1989 29 p
(RUU-CS-89-5; ETN-90-96770) Avail: NTIS HC A03/MF A01

A partitioning method and an associated distributed routing algorithm on hierarchically divided networks are presented. This algorithm is based on a newly defined metric: the hierarchical distance. Important features of the algorithm are: absence of centralized control, compact routing tables, locality of changes and extensibility. ESA

**N90-23987*#** Massachusetts Inst. of Tech., Cambridge. Lab. for Computer Science.
**RATE-BASED CONGESTION CONTROL IN NETWORKS WITH SMART LINKS, REVISION B.S. Thesis - May 1988**
Andrew Tyrrell Heybey Jan. 1990 39 p
(Contract NAG2-582; N00014-83-K-0125)
(NASA-CR-186698; NAS 1.26:186698; AD-A219852; MIT/LCS/TR-470-Rev) Avail: NTIS HC A03/MF A01 CSCL 09/2

The author uses a network simulator to explore rate-based congestion control in networks with smart links that can feed back information to tell senders to adjust their transmission rates. This method differs in a very important way from congestion control in which a congested network component just drops packets - the most commonly used method. It is clearly advantageous for the links in the network to communicate with the end users about the network capacity, rather than the users unilaterally picking a transmission rate. The components in the middle of the network, not the end users, have information about the capacity and traffic in the network. The author experiments with three different algorithms for calculating the control rate to feed back to the users. All of the algorithms exhibit problems in the form of large queues when simulated with a configuration modeling the dynamics of a packet-voice system. However, the problems are not with the algorithms themselves, but with the fact that feedback takes time. If the network steady-state utilization is low enough that it can absorb transients in the traffic through it, then the large queues disappear. If the users are modified to start sending slowly, to allow the network to adapt to a new flow without causing congestion, a greater portion of the network's bandwidth can be used. GRA

**N90-23988#** Utrecht State Univ. (Netherlands). Dept. of Computer Science.
**THE DISTRIBUTED BIT COMPLEXITY OF THE RING: FROM THE ANONYMOUS TO THE NON-ANONYMOUS CASE**
Hans L. Bodlaender, Shlomo Moran, and Manfred K. Warmuth (California Univ., Santa Cruz.) Nov. 1988 19 p Sponsored by Netherlands Organization for the Advancement of Pure Research
(Contract N00014-86-K-0454)
(RUU-CS-88-33; ETN-90-96855) Avail: NTIS HC A03/MF A01

The distributed bit complexity of an asynchronous network of processors is studied. The amount of communication required for any useful computation on the network is considered. An attempt is made to characterize networks by their bit complexity. Moran and Warmuth studied the bit complexity of a ring of n processors under tha assumption that all the processors in the ring are identical. Each processor is allowed to have a distinct identity, which becomes a second parameter to the program. If the set of possible identities grows double exponentially in n, then by a simple reduction to the anonymous case, the lower bound is shown to hold as well. ESA

**N90-23989#** Utrecht State Univ. (Netherlands). Dept. of Computer Science.
**STRUCTURED NC**
Bertha Scholten and Jan vanLeeuwen Mar. 1989 27 p
(RUU-CS-89-6; ETN-90-96861) Avail: NTIS HC A03/MF A01

The class of Structured NC (SNC), which is a subclass of NC (NC and AC being classes of problems solvable by logspace uniform families of circuits), is discussed. The SNC class has the property that any circuit in it should be structured. Distinctions between several subclasses of SNC are made. They differ in depth of the circuits and in fan-in and fan-out of the gates. Relations

among these subclasses and between these subclasses and NC and AC are derived. Techniques for transforming circuits from one class into equivalent circuits in other classes are described. ESA

# 63 CYBERNETICS

Includes feedback and control theory, artificial intelligence, robotics and expert systems.

For related information see also *54 Man/System Technology and Life Support.*

**N90-23990** Virginia Univ., Charlottesville.
**ADAPTIVE CONTROL OF A SYSTEM WITH PERIODIC DYNAMICS: APPLICATION OF AN IMPULSE RESPONSE METHOD TO THE HELICOPTER VIBRATION PROBLEM Ph.D. Thesis**
Carl Richard Knospe 1989 363 p
Avail: Univ. Microfilms Order No. DA9008170

An adaptive blade control algorithm for helicopter vibration reduction is developed as an application of an impulse response control method. The method is based on an impulse response formulation which is applicable to any linear system with periodic dynamics. For such systems, a matrix of discretized impulse responses defines the relationships between sequences of inputs and outputs sampled throughout a period. Under a nearly constant control vector assumption, the impulse response matrix is shown to be full, and for constant dynamics plants, belong to a class of matrices diagonalizable by Fast Fourier transforms, the circulant matrices. For systems with periodic input coefficients, a circulant/diagonal structure results. Such structures are shown to act as a theoretical link between impulse response control methods and frequency domain techniques. In the investigation of adaptive helicopter vibration control presented, a vertical-axis-only plant is simulated by a model composed of an impulse response matrix and an uncontrolled vibration vector. The adaptive control is implemented by a regulator composed of an estimator and a controller. The model parameters are identified by either Kalman or batch weighted least squares (WLS) filtering in either global or local form. The resulting estimates are used in an optimal control law obtained by the minimization of a constrained, single-step, quadratic performance function. Four control laws are derived: global certainty-equivalent, local certainty equivalent, global cautious, and local cautious. The filters derived are examined in open loop simulations to determine their identification capabilities independent of the control feedback. Two levels of open loop control variation are used to evaluate estimation performance with constant and time-varying plants. The Kalman filters are found to produce lower estimate errors than the WLS filters. Closed loop simulations of the regulators are then conducted with the filters retuned. Dissert. Abstr.

**N90-23991*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**AN EXPERT SYSTEM TO PERFORM ON-LINE CONTROLLER TUNING**
Jonathan S. Litt 1990 15 p Presented at the 1990 American Control Conference, San Diego, CA, 23-25 May 1990; sponsored by American Automatic Control Council
(DA Proj. 1L1-62211-A4-7A)
(NASA-TM-103101; E-5422; NAS 1.15:103101; AVSCOM-TR-90-C-007) Avail: NTIS HC A03/MF A01 CSCL 09B

An expert system which tunes a Proportional-Integral-Derivative (PID) controller on-line for a single-input-single-output multiple-lag process with dead time is described. The expert system examines features of the previous transient responses and their corresponding sets of controller parameters. It determines a new set of controller gains to obtain a more desirable time response. This technique can be used to determine and implement a different set of PID gains for each operating regime and, once in steady state, the system can be used to find optimal parameters for load disturbance rejection. The expert system can be applied to any system of the specified form (aerospace, industrial, etc.) and can be expanded to include additional process models. Author

**N90-23992#** Massachusetts Inst. of Tech., Cambridge. Artificial Intelligence Lab.
**DISPARITY GRADIENTS AND DEPTH SCALING**
Heinrich Buelthoff and Manfred Fahle Sep. 1989 16 p
(Contracts N00014-88-K-0164; N00014-85-K-0124; DACA76-85-C-0010; NSF IRI-87-19392)
(AD-A218612; AI-M-1175; CBIP-M-39) Avail: NTIS HC A03/MF A01 CSCL 12/9

The binocular perception of shape and of depth relations between objects can change considerably if the viewing direction is changed only by a small angle. We explored this effect psychophysically and found a strong depth reduction effect for large disparity gradients. The effect is found to be strongest for horizontally oriented stimuli, and stronger for line stimuli than for points. This depth scaling effect is discussed in a computational framework of stereo based on a Baysian approach which allows to integrate information from different types of matching primitives weighted according to their robustness. GRA

**N90-23993#** Syracuse Univ., NY.
**NORTHEAST ARTIFICIAL INTELLIGENCE CONSORTIUM. VOLUME 3: THE VERSATILE MAINTENANCE EXPERT SYSTEM RESEARCH PROJECT Annual Interim Report, Jan.-Dec. 1988**
Sargur N. Srihari, Stuart C. Shapiro, and Shambhu J. Upadhyaya Oct. 1989 54 p
(Contract F30602-85-C-0008; AF Proj. 5581)
(AD-A218716; RADC-TR-89-259-Vol-3) Avail: NTIS HC A04/MF A01 CSCL 12/9

The Northeast Artificial Intelligence Consortium is to conduct pertinent research in artificial intelligence and to perform activities ancillary to this research. Progress that was made in the fourth year of the Consortium on the Versatile Maintenance Expert System research task is described. Technical areas addressed include candidate ordering, reordering and elimination, representation and diagnosis of sequential circuits, shadowing of deep knowledge and user interfaces. Work was initiated on the use of a more complex circuit as the testbed for this research. GRA

**N90-23994#** Syracuse Univ., NY.
**NORTHEAST ARTIFICIAL INTELLIGENCE CONSORTIUM. VOLUME 4. DISTRIBUTED AI FOR COMMUNICATIONS NETWORK MANAGEMENT Annual Interim Report, Jan.-Dec. 1988**
Robert A. Meyer and Susan E. Conry Oct. 1989 94 p
(Contract F30602-85-C-0008; AF Proj. 5581)
(AD-A218717; RADC-TR-89-259-Vol-4) Avail: NTIS HC A05/MF A01 CSCL 12/5

The Northeast Artificial Intelligence Consortium (NAIC) was created by the Air Force Systems Command, Rome Air Development Center, and the Office of Scientific Research. Its purpose is to conduct pertinent research in artificial intelligence and to perform activities ancillary to this research. Progress that was made in the fourth year of the existence of the NAIC on the technical research tasks undertaken at the member universities is described. The topics covered in general are: versatile expert system for equipment maintenance, distributed AI for communications system control, automatic photointerpretation, time-oriented problem solving, speech understanding systems, knowledge-based reasoning and planning, knowledge base maintenance, hardware architectures for very large systems, and a knowledge acquisition, assistance, and explanation system. The specific topic for this volume is the use of knowledge-based systems for communications network management and control via an architecture for a diversely distributed multi-agent system. GRA

**N90-23995#** Pennsylvania State Univ., University Park. Applied Research Lab.
**A DECISION SUPPORT SYSTEM FOR CONTROL AND AUTOMATION OF DYNAMICAL PROCESSES M.S. Thesis**
Steve Nann Mar. 1990 152 p
(AD-A219501; ARL/PSU/TR-90-002) Avail: NTIS HC A08/MF A01 CSCL 12/4

The concept and development of a diagnostic decision support system for real-time control and automation of dynamic processes are presented. This system, known as DECA (Diagnostic Evaluation and Corrective Action), will take advantage of the computer's ability to manipulate vast amounts of data, and employ qualitative reasoning for the monitoring and diagnosis of dynamical processes during time-constrained, routine, and emergency situations where an immediate response is necessary to avoid catastrophic failure of the system. The software system's architecture was structured in such a manner that is can be applied to any dynamic process without reprogramming. DECA is written in Lisp and was verified using the data from the Three Mile Island Nuclear Reactor Accident. GRA

**N90-23996#** Naval Postgraduate School, Monterey, CA.
**REAL TIME ADAPTIVE CONTROL OF AN AUTONOMOUS UNDERWATER VEHICLE (AUV) M.S. Thesis**
Michael H. Davis Sep. 1989 66 p
(AD-A219544) Avail: NTIS HC A04/MF A01 CSCL 13/10

The problem of designing a controller for the dive maneuver of an Autonomous Underwater Vehicle (AUV) is addressed. The highly nonlinear nature of the vehicle dynamics and the requirement for the fast maneuvering call for robust control techniques. In particular Variable Structure Control (VSC) combined with Adaptive Control (AC) techniques seem to yield satisfactory performance in terms of robustness, capability to adjust to different operating conditions, and speed of response. Also linear robust techniques based on LQG and robust observers are presented to address the case when the whole state (in terms of pitch rate, pitch, and depth) is not available for measurement. GRA

**N90-23997#** Naval Postgraduate School, Monterey, CA.
**DESIGN AND INVESTIGATION OF A DIVE PLANE SLIDING MODE COMPENSATOR FOR AN AUTONOMOUS UNDERWATER VEHICLE M.S. Thesis**
Joo-No Sur Sep. 1989 129 p
(AD-A219552) Avail: NTIS HC A07/MF A01 CSCL 13/10

A sliding mode compensator for depth control of an autonomous underwater vehicle (AUV) using depth feedback only is designed. The controller is evaluated for a nominal linear model and optimized by a series of numerical experiments for a number of depth changing maneuvers. A state observer is used in order to estimate the unmeasurable states together with the sliding mode controller. The effects of varying control parameters are discussed. Compensator performance is assessed by numerical simulation of AUV dynamic response based on the full six degrees of freedom nonlinear equations of motion. The expected robustness of the design is demonstrated by comparison between linear and nonlinear vehicle response characteristics, and by a wide variation in vehicle parameters and hydrodynamic coefficients. Finally, suggestions for design improvement and directions for future research are indicated. GRA

**N90-23998#** Harvard Univ., Cambridge, MA.
**ADAPTIVE FILTERING AND CONTROL Final Report, 1 Jul. 1988 - 30 Jun. 1989**
R. W. Brockett 1 Nov. 1989 3 p
(Grant AF-AFOSR-0197-86; AF Proj. 2304)
(AD-A219556; AFOSR-90-0307TR) Avail: NTIS HC A01/MF A01 CSCL 12/4

Algorithms were developed which evolve in continuous time and which are capable of accomplishing a wide variety of computations of the type which can be used in making systems adaptive. Examples range from computations done by finite automata to differential equations which compute the eigenvalues of matrices. GRA

**N90-23999#** Northeast Artificial Intelligence Consortium, Syracuse, NY.
**NORTHEAST ARTIFICIAL INTELLIGENCE CONSORTIUM ANNUAL REPORT, 1988. VOLUME 12: COMPUTER ARCHITECTURES FOR VERY LARGE KNOWLEDGE BASES Interim Report, Jan. - Dec. 1988**
P. Bruce Berra, Arif Ghafoor, Soon Myoung Chung, Nabil I. Hachem, Slawomir J. Marcinkowski, Periklis A. Mitkas, and Donghoon Shin Oct. 1989 307 p
(Contract F30602-85-C-0008; AF Proj. 5581)
(AD-A219599; RADC-TR-89-259-Vol-12) Avail: NTIS HC A14/MF A02 CSCL 12/9

The Northeast Artificial Intelligence Consortium (NAIC) was created by the Air Force Systems Command, Rome Air Development Center, and the Office of Scientific Research. Its purpose is to conduct pertinent research in artificial intelligence and to perform activities ancillary to this research. This report describes progress that has been made in the fourth year of the existence of the NAIC on the technical research tasks undertaken at the member universities. The topics covered in general are: versatile expert system for equipment maintenance, distributed AI for communications system control, automatic photointerpretation, and time-oriented problem solving, speech understanding systems, knowledge base maintenance, hardware architectures for very large systems, knowledge-based reasoning and planning, and a knowledge acquisition, assistance, and explanation system. The specific topic for this volume is the development of architectures for very large knowledge bases, especially in light of real-time requests, parallelism and the advent of optical computing. GRA

**N90-24000#** Naval Postgraduate School, Monterey, CA. Dept. of Electrical and Computer Engineering.
**NEURAL NETWORKS APPLIED TO SIGNAL PROCESSING M.S. Thesis**
Mark D. Baehre Sep. 1989 107 p
(AD-A219605) Avail: NTIS HC A06/MF A01 CSCL 12/9

The relationship between the structure of a neural network and its ability to perform nonlinear mapping is analyzed. A new algorithm, called the conjugate gradient optimization method, for calculating the weights and thresholds of a neural network is presented. The performance of the conjugate gradient algorithm is then compared to the well known backpropagation method and shown to be more computationally efficient. A neural network using the conjugate gradient algorithm is then applied to three simple examples to demonstrate its signal processing capabilities. The first example illustrates the ability of the neural network to perform classification. The second compares the performance of a neural network predictor and is shown to provide much greater accuracy than its linear counterpart. The final application presented demonstrates the ability of a neural network to perform channel equalization for a nonminimum phase channel. Its performance is then compared to its linear equivalent. GRA

**N90-24001#** Connecticut Univ., Storrs. Dept. of Electrical and Systems Engineering.
**STOCHASTIC ADAPTIVE CONTROL AND ESTIMATION ENHANCEMENT Final Report**
Y. Bar-Shalom Feb. 1990 89 p
(Grant AF-AFOSR-0202-88; AF Proj. 2304)
(AD-A219629; AFOSR-90-0303TR) Avail: NTIS HC A05/MF A01 CSCL 12/3

The investigations summarized in this report deal with: adaptive dual control of systems with unknown parameters; estimation and control of hybrid stochastic systems; distributed estimation in systems with measurements of uncertain origin; solution of continuous-time hybrid stochastic differential equations; and of point process theory for target mode estimation. The report consists primarily of 10 preprints and reprints. GRA

**N90-24002#** Aerospatiale, Chatillon (France).
**A VIEWPOINT ON THE CONTRIBUTION OF EXPERT SYSTEMS OF LOGISTICS**

Serge Dupuy 1989 10 p
(Rept-892-320-101; ETN-90-96625) Avail: NTIS HC A02/MF A01

A brief reminder of artificial intelligence (AI) and expert systems (ES) is presented, with the aim of inferring basic lessons from the ES experience. For any ES project, it is recommended not to ignore any actor to avoid resulting in a systematic failure: end user, expert, knowledge engineer, and data processing specialist. Difficulties relating to methodology, validation and processing of uncertainty are remarked. ESA

**N90-24003#** Technische Univ., Eindhoven (Netherlands). Dept. of Mathematics and Computing Science.
**THE DISCRETE TIME H INFINITY CONTROL PROBLEM: THE FULL-INFORMATION CASE**
A. A. Stoorvogel Sep. 1989 15 p
(MEMO-COSOR-89-25; ETN-90-96726) Avail: NTIS HC A03/MF A01

The discrete time, full-information H sub infinity control problem is investigated. It turns out that, as in the continuous time case, the existence of an internally stabilizing controller which makes the H sub infinity norm strictly less than 1 is related to the existence of a stabilizing solution to an algebraic Riccati equation. The solution of this algebraic Riccati equation has to satisfy an extra condition. It is interesting to note that in general state feedbacks do not suffice and the disturbance has to be included in the feedback. ESA

**N90-24004#** Technische Univ., Eindhoven (Netherlands). Dept. of Mathematics and Computer Science.
**COMPLETION OF THE SQUARES IN THE FINITE HORIZON H INFINITY CONTROL PROBLEM BY MEASUREMENT FEEDBACK**
H. L. Trentelman and A. A. Stoorvogel Oct. 1989 15 p
(MEMO-COSOR-89-27; ETN-90-96728) Avail: NTIS HC A03/MF A01

The finite horizon version of the standard H to the (infinity) power control problem by measurement feedback is studied. Given a finite-dimensional linear, time-invariant system, together with a positive real number gamma, necessary and sufficient conditions are obtained for the existence of a possibility time-varying dynamic compensator such that the L sub 2 (0,T)-induced norm of the closed loop operator is smaller than gamma. These conditions are expressed in terms of a pair of quadratic differential inequalities, generalizing the well-known Riccati differential equations introduced recently in the context of finite horizon H to the (infinity) power control. ESA

**N90-24005#** Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Operations Research, Statistics, and System Theory.
**ALMOST DISTURBANCE DECOUPLING BY MEASUREMENT FEEDBACK: A FREQUENCY DOMAIN ANALYSIS**
J. W. vanderWoude Jun. 1989 11 p
(CWI-BS-R8910; ETN-90-96747) Copyright Avail: NTIS HC A03/MF A01

The almost disturbance decoupling problem by measurement feedback is formulated for systems described by transfer matrices. Necessary and sufficient conditions in frequency domain terms for the solvability of the problem are given. The conditions are derived using frequency domain techniques. The linear system under analysis is described. Some notions concerning the various types of solvability for rational matrix equations are presented. A new algorithm for the computation of a controller which achieves almost decoupling up to a specified accuracy is given. ESA

**N90-24006#** Massachusetts Univ., Amherst. Dept. of Computer and Information Science.
**INTELLIGENT, REAL-TIME PROBLEM SOLVING Final Report, 15 Sep. - 14 Dec. 1989**
Paul Cohen and David M. Hart 8 Mar. 1990 87 p
(Contract F49620-89-C-0121)
(AD-A219929; AFOSR-90-0324TR) Avail: NTIS HC A05/MF A01 CSCL 12/5

A testbed for intelligent, real-time problem solving systems has been enhanced for use by the broader research community. The testbed, part of the Phoenix system, simulates forest fires and autonomous agents who try to control them. Under this contract, the testbed was modularized for portability to other researchers using Explorers or MicroExplorers. Instrumentation was added for experimentation and baseline scenarios developed for typical real-time problems found in this domain. A reference manual for the testbed was written. GRA

# 64 NUMERICAL ANALYSIS

Includes iteration, difference equations, and numerical approximation.

**N90-24007*#** Research Inst. for Advanced Computer Science, Moffett Field, CA.
**EXPLICITLY SOLVABLE COMPLEX CHEBYSHEV APPROXIMATION PROBLEMS RELATED TO SINE POLYNOMIALS**
Roland Freund Feb. 1989 9 p Prepared in cooperation with Wuerzburg Univ., Fed. Republic of Germany
(Contract NCC2-387)
(NASA-CR-181575; NAS 1.26:181575; RIACS-TR-89.4) Avail: NTIS HC A02/MF A01 CSCL 12A

Explicitly solvable real Chebyshev approximation problems on the unit interval are typically characterized by simple error curves. A similar principle is presented for complex approximation problems with error curves induced by sine polynomials. As an application, some new explicit formulae for complex best approximations are derived. Author

**N90-24008*#** Research Inst. for Advanced Computer Science, Moffett Field, CA.
**CHEBYSHEV POLYNOMIALS ARE NOT ALWAYS OPTIMAL**
Bernd Fischer and Roland Freund (Wuerzburg Univ., Germany, F.R. ) Apr. 1989 16 p Prepared in cooperation with Stanford Univ., CA
(Contract NCC2-387)
(NASA-CR-181465; NAS 1.26:181465; RIACS-TR-89.17) Avail: NTIS HC A03/MF A01 CSCL 12A

The problem is that of finding among all polynomials of degree at most n and normalized to be 1 at c the one with minimal uniform norm on Epsilon. Here, Epsilon is a given ellipse with both foci on the real axis and c is a given real point not contained in Epsilon. Problems of this type arise in certain iterative matrix computations and, in this context, it is generally believed and widely referenced that suitably normalized Chebyshev polynomials are optimal for such constrained approximation problems. It is shown that this is not true in general. Moreover, sufficient conditions are derived which guarantee that Chebyshev polynomials are optimal. Some numerical examples are also presented. Author

**N90-24009*#** Research Inst. for Advanced Computer Science, Moffett Field, CA.
**ON THE PARALLEL SOLUTION OF PARABOLIC EQUATIONS**
E. Gallopoulos and Youcef Saad May 1989 24 p
(Contract NCC2-387)
(NASA-CR-180363; NAS 1.26:180363; RIACS-TR-89.19) Avail: NTIS HC A03/MF A01 CSCL 12A

Parallel algorithms for the solution of linear parabolic problems are proposed. The first of these methods is based on using polynomial approximation to the exponential. It does not require solving any linear systems and is highly parallelizable. The two other methods proposed are based on Pade and Chebyshev approximations to the matrix exponential. The parallelization of these methods is achieved by using partial fraction decomposition techniques to solve the resulting systems and thus offers the potential for increased time parallelism in time dependent problems.

Experimental results from the Alliant FX/8 and the Cray Y-MP/832 vector multiprocessors are also presented. Author

**N90-24010*#** Research Inst. for Advanced Computer Science, Moffett Field, CA.
**NUMERICAL SOLUTION OF LARGE LYAPUNOV EQUATIONS**
Youcef Saad May 1989 13 p
(Contract NCC2-387)
(NASA-CR-180359; NAS 1.26:180359; RIACS-TR-89.20) Avail: NTIS HC A03/MF A01 CSCL 12A

A few methods are proposed for solving large Lyapunov equations that arise in control problems. The common case where the right hand side is a small rank matrix is considered. For the single input case, i.e., when the equation considered is of the form AX + XA(sup T) + bb(sup T) = 0, where b is a column vector, the existence of approximate solutions of the form X = VGV(sup T) where V is N x m and G is m x m, with m small is established. The first class of methods proposed is based on the use of numerical quadrature formulas, such as Gauss-Laguerre formulas, applied to the controllability Grammian. The second is based on a projection process of Galerkin type. Numerical experiments are presented to test the effectiveness of these methods for large problems. Author

**N90-24011*#** Research Inst. for Advanced Computer Science, Moffett Field, CA.
**ON BERNSTEIN TYPE INEQUALITIES AND A WEIGHTED CHEBYSHEV APPROXIMATION PROBLEM ON ELLIPSES**
Roland Freund (Wuerzburg Univ., Germany, F.R. ) May 1989 13 p
(Contract NCC2-387)
(NASA-CR-180368; NAS 1.26:180368; RIACS-TR-89.21) Avail: NTIS HC A03/MF A01 CSCL 12A

A classical inequality due to Bernstein which estimates the norm of polynomials on any given ellipse in terms of their norm on any smaller ellipse with the same foci is examined. For the uniform and a certain weighted uniform norm, and for the case that the two ellipses are not too close, sharp estimates of this type were derived and the corresponding extremal polynomials were determined. These Bernstein type inequalities are closely connected with certain constrained Chebyshev approximation problems on ellipses. Some new results were also presented for a weighted approximation problem of this type. Author

**N90-24012#** Oak Ridge National Lab., TN. Mathematical Sciences Section.
**HYPERSINGULAR INTEGRALS AND THE TWO DIMENSIONAL HELMHOLTZ EQUATION**
L. J. Gray 1990 11 p Presented at the Japan/USA Symposium, Palo Alto, CA, 5-7 Jun. 1990
(Contract DE-AC05-84OR-21400)
(DE90-009821; CONF-9006167-1) Avail: NTIS HC A03/MF A01

Hypersingular integral equations have proven to be very effective tool in the boundary element analysis of regions containing cracks. In previous studies, the reduction of the singular terms to a computationally reasonable form has relied on the the ability to analytically integrate the Green's function over a flat element. The purpose is to investigate the integration of a more complicated fundamental solution, that of the two-dimensional Helmholtz equation, over a curved element. The Hankel functions are treated by integrating the singular part analytically, and other Green's functions. However, the higher-dimensional analogue of the procedure employed herein to treat the quadratic isoparametric element is not practical, and other techniques will be required. DOE

**N90-24013#** Rome Univ. (Italy). Dipt. di Fisica.
**ON A METHOD FOR COMPUTING EIGENVALUES AND EIGENFUNCTIONS OF LINEAR DIFFERENTIAL OPERATORS**
M. Bruschi, R. G. Campos (Michoacana Univ., Morelia Michoacan, Mexico ), and E. Pace 5 Oct. 1989 43 p Submitted for publication Sponsored by an Italian government fellowship
(Preprint-706; ETN-90-96529) Avail: NTIS HC A03/MF A01

A simple method is presented to compute the eigenvalues and the eigenfunctions of second order linear differential operators, with homogeneous boundary conditions, both in a finite interval and on the semi-line. The technique overcomes the drawbacks of the method in computing the eigenvalues of Sturm-Liouville problems in a finite interval. An estimate of the convergence for the eigenvalues is given in the finite case and numerical tests are performed, exhibiting a very fast rate of convergence for the eigenvalues both for the finite interval and the semiline cases. An excellent convergence for the eigenfunctions is obtained in both cases. ESA

**N90-24014#** Johns Hopkins Univ., Baltimore, MD. Dept. of Electrical and Computer Engineering.
**EFFICIENT SMOOTHING FOR BOUNDARY VALUE MODELS**
Howard L. Weinert 29 Dec. 1989 9 p
(Contract N00014-89-J-1642)
(AD-A218484; JHU/ECE-89-20) Avail: NTIS HC A02/MF A01 CSCL 12/1

The smoothing problem for two-point boundary value models is investigated. By triangularizing the relevant Hamiltonian system, one can derive a new smoothing algorithm which is twice as fast as the one which was obtained by diagonalizing the Hamiltonian. GRA

**N90-24015#** Science and Technology Corp., Hampton, VA.
**ANALYTIC PARABOLIC EQUATION SOLUTIONS Final Report**
Nov. 1989 59 p
(Contract N66001-88-D-0115)
(AD-A218588; STC-3021; NOSC/TD-1706) Avail: NTIS HC A04/MF A01 CSCL 20/1

This document presents a Gaussian Beam (GB) method for underwater acoustic propagation, with emphasis on critical reflection and head wave modeling due to a high velocity bottom. GRA

**N90-24016#** Alberta Univ., Edmonton.
**BILATERAL PREDICTION**
Robert J. Elliott Jul. 1989 8 p
(Contract DAAL03-87-K-0102)
(AD-A219564; ARO-24919.1-MA) Avail: NTIS HC A02/MF A01 CSCL 09/1

Semimartingale decompositions and prediction problems are discussed for a diffusion observed through a two-sided filtration. GRA

**N90-24017#** Tennessee Univ., Knoxville. Dept. of Mathematics.
**INTEGRAL AND SERIES REPRESENTATION OF INFINITELY DIVISIBLE PROCESSES WITH APPLICATIONS TO THEIR PREDICTION AND TO THEIR SAMPLE PATH, STATISTICAL, AND STRUCTURAL PROPERTIES Final Report, 1 Apr. 1987 - 31 Jul. 1989**
Balram S. Rajput and Jan Rosinski 31 Jul. 1989 13 p
(Grant AF-AFOSR-0136-87; AF Proj. 2304)
(AD-A219625; AFOSR-90-0298TR) Avail: NTIS HC A02/MF A01 CSCL 12/3

The Gaussian model has been used to describe many random phenomena in science and engineering because of its versatility and mathematical simplicity. However, the Gaussian model is not universally applicable; and, in fact, there are many instances, both in the areas of theoretical research and engineering applications, where the need of non-Gaussian models, particularly those with infinite variance, can be identified. For instance, man-made noise in a hostile environment can be made to depart from Gaussian behavior; and the natural noise occurring in situations where weak signals need to be extracted also tends to not follow the Gaussian pattern. These are but a few examples that might be of particular interest to defense agencies, where non-Gaussian modeling and their analysis are most desirable. GRA

**N90-24018#** California Univ., Los Angeles. Cognitive Systems Lab.
**DYNAMIC CONSTRAINTS NETWORKS Final Report, 1 May 1988 - 31 Oct. 1989**
Judea Pearl 31 Oct. 1989 4 p
(Grant AF-AFOSR-0177-88; AF Proj. 2304)
(AD-A219778; AFOSR-90-0344TR) Avail: NTIS HC A01/MF A01 CSCL 12/2

The objective of this effort was to develop a comprehensive and efficient model of dynamic constraint networks. The current available systems are either too complicated to understand of quite limited. They are not based on well understood theories. Their capabilities and boundaries are not formally assessed. This prevents comparison of different approaches which is essential in a process of developing and improving a model. A theory based on static approach to constrained networks was used to develop a dynamic theory of constraint networks for problem solving. The scientific results of this development resulted in six scientific publications. GRA

**N90-24019#** Massachusetts Inst. of Tech., Cambridge. Dept. of Mathematics.
**NUMERICAL CONFORMAL MAPPING AND APPLICATIONS Final Technical Report, 1 Dec. 1986 - 30 Nov. 1989**
Lloyd N. Trefethen 26 Feb. 1990 19 p
(Grant AF-AFOSR-0102-87; AF Proj. 2304)
(AD-A219789; AFOSR-90-0356TR) Avail: NTIS HC A02/MF A01 CSCL 12/1

During the period covered by the grant, ten papers were written. Titles include: Error Bounds for Newton Refinement of Solutions to Algebraic Riccati Equations, Computable Bounds for the Sensitivity of Algebraic Riccati Equations, and Estimating the Distance to the Nearest Uncontrollable Pair through the Algebraic Riccati Equation. GRA

**N90-24020#** Tennessee Univ., Knoxville. Dept. of Mathematics.
**EFFICIENT NUMERICAL METHODS FOR EVOLUTION PARTIAL DIFFERENTIAL EQUATIONS Final Report, 1 Oct. 1987 - 30 Sep. 1989**
Lhannes Karakashian 30 Sep. 1989 5 p
(Grant AF-AFOSR-0019-88; AF Proj. 2304)
(AD-A219790; AFOSR-90-0334TR) Avail: NTIS HC A01/MF A01 CSCL 12/1

The convergence estimates obtained for the Korteweg-de Virus equation were generalized, under the assumption that the solution u is sufficiently regular. For p 4, it is not known whether a global smooth solution exists corresponding to smooth initial data. It is in fact conjectured that for these cases, the solution may develop a singularity in finite time. A code that uses a spatially and temporally adaptive strategy has been implemented. We are currently investigating the stability of solitary type solutions. As conjectured, these solutions are highly unstable for initial amplitudes larger than one. GRA

**N90-24021#** Brown Univ., Providence, RI. Center for Neural Science.
**AN AVERAGING RESULT FOR RANDOM DIFFERENTIAL EQUATIONS**
Nathan Intrator 12 Apr. 1990 14 p
(Contract N00014-86-K-0041)
(AD-A220364; AD-E501205; TR-54) Avail: NTIS HC A03/MF A01 CSCL 12/1

Differential equations which contain strong mixing random processes are examined. The solution process is shown to be well approximated by a deterministic trajectory, over an infinite time interval, using the interplay between the rate of fluctuations of the random process and the rate of the psi mixing. An application of the result is given for analyzing synaptic modifications in neural networks. GRA

**N90-24022#** California Univ., Los Angeles. Dept. of Electrical Engineering.
**DISCRETE MATHEMATICS FOR COMMUNICATION SYSTEMS Abstracts Only Final Technical Report, 1 Feb. 1984 - 31 Jan. 1990**
Solomon W. Golomb 31 Mar. 1990 47 p
(Contract N00014-84-K-0189)
(AD-A220430) Avail: NTIS HC A03/MF A01 CSCL 12/1

Papers presented include: Tuscan-K Squares; Bounds for Arrays of Dots with Distinct Slopes or Distinct Differences; Algebraic Constructions for Frequency Hop Patterns; Constructions for Perfect Maps and Pseudo-Random Arrays; On Hamiltonian Decomposition of K(sub n)* Patterns with Distinct Differences, and Tuscan Squares; Florentine Rows or Left-Right Shifted Permutation Matrices with Cross Correlation Values less than or = to 1; Fragments of Symmetry in Circular Rows; The Ungracefulness of an Extended Pentagon for a Problem Posed by Knuth; A Distinct Distance Set of 9 Nodes in a Tree of Diameter 36. GRA

**N90-24023#** Massachusetts Inst. of Tech., Lexington. Lincoln Lab.
**A MODIFIED FAST FOURIER TRANSFORM**
Arden L. Steinbach and Cynthia H. Warner 24 Jan. 1990 60 p
Original contains color illustrations
(Contract F19628-90-C-0002)
(AD-A220567; TR-867; ESD-TR-89-229) Avail: NTIS HC A04/MF A01 CSCL 12/1

This report presents a derivation of the modified discrete Fourier transform, which has the property that the origin in frequency space appears in the center of the plot rather than at the edges (one dimension) or at the four corners (two dimensions), as in conventional treatments. Also included is a listing of an unusual fast Fourier transform (FFT) program for calculating the two-dimensional, modified discrete Fourier transform. The computer program makes use of the Eklundh fast matrix transposition algorithm and can transform arrays that are much too large to fit within the internal memory of the computer. By way of example, a complex array of size 2048 X 2048 can easily be transformed on a microcomputer with a 40-MB hard disk. GRA

**N90-24024#** Technische Univ., Delft (Netherlands). Faculty of Technical Mathematics and Informatics.
**COMPENSATABILITY AND OPTIMAL COMPENSATION OF SYSTEMS WITH STOCHASTIC PARAMETERS**
W. L. deKoning 1989 32 p
(Rept-89-61; ISSN-0922-5641; ETN-90-96665) Copyright Avail: NTIS HC A03/MF A01

The optimal compensation problem is considered in the case of linear discrete time systems with white stocastic parameters, and quadratic criteria. A generalization of the notion of mean square stabilizability, namely mean square compensatability, is introduced. Suitable mean square compensatability and detectability conditions are shown to be sufficient, and necessary in general, for the existence of a unique optimal mean square stabilizing compensator. Tests to determine if a system is mean square compensatable or not are given. The method of numerically calculating the tests and the optimal mean square stabilizing compensator is indicated. The results are illustrated with examples. ESA

**N90-24025#** Technische Univ., Delft (Netherlands). Faculty of Technical Mathematics and Informatics.
**TOPOLOGICAL CLASSIFICATION OF STRUCTURALLY STABLE QUADRATIC SYSTEMS WITHOUT LIMIT CYCLES**
Zhu Deming 1989 19 p Transl. into ENGLISH from Nanjing Daxue Xuebao (Peoples Republic of China), v. 22, no. 2 p 263-273
(Rept-89-66; ISSN-0922-5641; ETN-90-96668) Copyright Avail: NTIS HC A03/MF A01

By means of the construction of four examples, 4 classes are shown not empty, and the topological structures of 10 classes cannot be realized. Among the structurally stable quadratic systems without limit cycles, at most 50 different topological structures are

concluded to be distinguishable, of which 37 have already been shown to exist. ESA

**N90-24026#** Technische Univ., Delft (Netherlands). Faculty of Technical Mathematics and Informatics.
**NUMERICAL SOLUTION OF A BIFURCATION PROBLEM FOR THE BOUSSINESQ EQUATIONS AT LOW PRANDTL NUMBERS BY A MULTIGRID METHOD**
S. Zeng and P. Wesseling 1989 31 p
(Rept-89-67; ISSN-0922-5641; ETN-90-96669) Copyright Avail: NTIS HC A03/MF A01

A nonlinear multigrid method is used to solve a bifurcation problem in fluid mechanics. Time derivatives are discretized by the Crank-Nicholson formula and spatial derivatives by the hybrid scheme. At each time step the equation system is solved by the multigrid algorithm. Bifurcation is observed only if the numerical solution at each time step is accurate enough. Sufficient accuracy is obtained by applying one defect correction iteration. The results are in agreement with those obtained using different methods. The computation cost is discussed. ESA

**N90-24027#** Technische Univ., Delft (Netherlands). Faculty of Technical Mathematics and Informatics.
**A LINE RELAXATION SMOOTHER FOR THE MULTIGRID SOLUTION OF THE BOUSSINESQ EQUATIONS**
S. Zeng and P. Wesseling 1989 27 p
(Rept-89-68; ISSN-0922-5641; ETN-90-96670) Copyright Avail: NTIS HC A03/MF A01

A multigrid algorithm using a smoother with line relaxation is developed to overcome convergence problems resulting from large cell aspects ratios. The Boussinesq equations are solved by this algorithm for a problem of free conversion in a rectangular domain. Results concerning convergence histories and computational cost are presented. The algorithm control structure of the smoother is given, allowing the implementation of different types of smoothings. ESA

**N90-24028#** Technische Univ., Delft (Netherlands). Faculty of Technical Mathematics and Informatics.
**A UNIFORM REPRESENTATION SCHEME FOR FREEFORM GEOMETRIC MODELING**
J. J. Steketee 1989 25 p
(Rept-89-70; ISSN-0922-5641; ETN-90-96672) Copyright Avail: NTIS HC A03/MF A01

The mesh-subdivision scheme, a uniform scheme for the representation of objects used in freeform geometric modeling, is discussed. The scheme has two parts: a mesh representing the topological structure and approximating the geometric structure, and a recursive subdivision method, using parameters to control the shape of the object. It is shown that the problem of self-intersection in known recursive subdivision methods can be solved, and it is indicated how freeform solid modeling methods can be integrated in the scheme. ESA

**N90-24029#** Technische Univ., Delft (Netherlands). Faculty of Technical Mathematics and Informatics.
**A BIBLIOGRAPHY OF THE QUALITATIVE THEORY OF QUADRATIC SYSTEMS OF DIFFERENTIAL EQUATIONS IN THE PLANE**
J. W. Reijn 1989 160 p
(Rept-89-71; ISSN-0922-5641; ETN-90-96673) Copyright Avail: NTIS HC A08/MF A01

With the goal of making a complete collection of all possible phase portraits of quadratic systems, preferably with for each phase portrait the corresponding values of the coefficients a(sub ij) and b(sub ij), a bibliography is presented. Only references which contain results on qudratic systems are listed. Completeness is aimed at but probably not achieved. ESA

**N90-24030#** Technische Univ., Delft (Netherlands). Faculty of Technical Mathematics and Informatics.
**CYCLOTOMY AND ASSOCIATION SCHEMES**
H. L. Claasen and R. W. Goldbach 1989 128 p
(Rept-89-73; ISSN-0922-5641; ETN-90-96675) Copyright Avail: NTIS HC A07/MF A01

In the second of three studies, the cyclotomic character of nonsymmetric association schemes with 3 classes are considered. Association schemes on commutative groups and cyclotomic schemes on rings are studied. Cyclotomic schemes over fields are considered and previous results used to develop properties of them. A necessary and sufficient condition for the imprimitivity of cyclotomic schemes over fields is given. Finite rings with unity are considered for the treatment of cyclotomic schemes. Properties of difference sets in the context of cyclotomy are considered. ESA

**N90-24031#** Technische Univ., Delft (Netherlands). Faculty of Technical Mathematics and Informatics.
**FIXED POINT THEORY IN MULTIPLY ORDERED SPACES**
Hans vanMaaren 1989 20 p
(Rept-89-74; ISSN-0922-5641; ETN-90-96676) Copyright Avail: NTIS HC A03/MF A01

The demonstration of Knaster-Kuratowski-Mazurkiewicz type theorem within the setting of multiply ordered spaces is given. A multiply ordered space is a topological space supplied with a finite number of continuous complete orderings. These orderings are used to define a simplicial subdivision-resembling structure on the space involved, in an explicit manner. The orderings give rise to a combinatorial boundary concept and a new type of convexity. Results are valid in some non metrizable spaces. Applied within the context of Euclidean space, a statement much stronger than the classical Knaster-Kuratowski-Mazurkiewicz theorem is obtained. ESA

**N90-24032#** Technische Univ., Delft (Netherlands). Faculty of Technical Mathematics and Informatics.
**APPLICATIONS OF DYNAMICAL SYSTEMS THEORY TO FRACTALS: A STUDY OF COOKIE-CUTTER CANTOR SETS**
Tim Bedford 1989 46 p Submitted for publication
(Rept-89-76; ISSN-0922-5641; ETN-90-96678) Copyright Avail: NTIS HC A03/MF A01

Cookie-cutter Cantor sets in the line are studied as simple examples of fractals which are invariant sets of dynamical systems. The topics covered are: the characterization of a cookie-cutter via a dynamical system or an interated function system; introduction of measure theoretic and topological entropy and comparison with the concept of dimension; Bowen's formula for Hausdorff dimension; a flow canonically associated with a cookie-cutter Cantor set; the order two density of Hausdorff measure (a characterization of lacunarity); the multifractal spectrum for cookie-cutters; and, Sullivan's classification theorem for cookie-cutters. ESA

**N90-24033#** Technische Univ., Delft (Netherlands). Faculty of Technical Mathematics and Informatics.
**QUADRATIC SYSTEMS WITH THREE SADDLES AND ONE ANTISADDLE**
A. Zegeling 1989 64 p
(Rept-89-80; ISSN-0922-5641; ETN-90-96681) Copyright Avail: NTIS HC A04/MF A01

The phase portraits of a certain class of real autonomous differential equations in the plane with quadratic nonlinearities (quadratic systems) are analyzed and classified. The class is that with three saddles and one antisaddle in the finite plane. A first classification is made by using an isocline argument. Classification is describing the bifurcation set in the parameter space. Four bifurcation types are studied: the appearance of multiple limit cycles; saddle connections; a critical point with purely imaginary eigenvalues; higher order critical points at infinity. ESA

**N90-24034#** Technische Univ., Delft (Netherlands). Faculty of Technical Mathematics and Informatics.
**INFINITE SEPARATRIX CYCLES IN THE CRITICAL CASE, DIVERGENCE AND UNIQUENESS OF LIMIT CYCLES OF A QUADRATIC DIFFERENTIAL SYSTEM**

Ye Yanqian 1989 21 p
(Rept-89-87; ISSN-0922-5641; ETN-90-96686) Copyright Avail: NTIS HC A03/MF A01

An investigation into quadratic differential systems is presented. The existence of the infinite separatrix cycle in the critical case is investigated. Properties of quadratic curves under Coppel's condition are analyzed. When a line cycle exists it is conjectured that the intersection points with the curves must lie inferior to the line cycle, and that each line cycle can intersect only one branch under Coppel's conditions. ESA

**N90-24035#** Technische Univ., Eindhoven (Netherlands). Dept. of Mathematics and Computing Science.
**AN ASYMMETRIC SHORTEST QUEUE PROBLEM**
I. J. B. F. Adan, J. Wessels, and W. H. M. Zijm Aug. 1989 13 p
(MEMO-COSOR-89-22; ETN-90-96723) Avail: NTIS HC A03/MF A01

A system consisting of two identical servers, each with exponentially distributed service times is studied. Jobs arrive according to a Poisson stream. On arrival a job joins the shortest queue and in case queues have equal length, joins queue 1 say with probability q and queue 2 with probability 1-q, where q is arbitrary between 0 and 1. It is shown that the stationary queue length distribution can be represented by an infinite sum of product form solutions, which satisfy recurrence relations. The successive terms of the infinite sum are calculated. The convergence of the infinite sum is exponentially fast. A numerically highly attractive algorithm is obtained. ESA

**N90-24036#** Technische Univ., Eindhoven (Netherlands). Dept. of Mathematics and Computing Science.
**SKEW-SYMMETRIC MATRICES IN CLASSICAL MECHANICS**
D. A. Overdijk Aug. 1989 21 p
(MEMO-COSOR-89-23; ETN-90-96724) Avail: NTIS HC A03/MF A01

The use of the exponential function with skew-symmetric matrix argument in three dimensional kinematics is discussed. The representation of the orthogonal matrix corresponding to a rotation as the product of three exponentials is presented. The concept of generalized coordinates and generalized velocities of a system of particles is discussed. The inertia tensor of rigid coordinate systems and inertial forces in connection with Newton's second law of motion is given. The Lagrangian formulation of the equations of motion for discrete systems of particles is described. Lagrange's equations of motion for rigid systems of particles are derived. ESA

**N90-24037#** Technische Univ., Eindhoven (Netherlands). Dept. of Mathematics and Computer Science.
**LINEAR-QUADRATIC PROBLEMS AND THE RICCATI EQUATION**
A. H. W. Geerts and M. L. J. Hautus Oct. 1989 21 p
(MEMO-COSOR-89-26; ETN-90-96727) Avail: NTIS HC A03/MF A01

An overview of the results relating the Riccati equation with the Linear Quadratic (LQ) control problem is given. It is demonstrated that the LQ problem can be solved by using the Riccati equation or its generalization, the dissipation inequality. The singular case is reduced to the regular case via the generalized dual structure algorithm. The dissipation inequality permits the solution to be expressed directly in terms of the original data and reduces the indefinite case to semidefinite case. ESA

**N90-24038#** Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Numerical Mathematics.
**CONVERGENCE PROPERTIES OF THE RUNGE-KUTTA-CHEBYSHEV METHOD**
J. G. Verwer, Willem H. Hundsdorfer, and B. P. Sommeijer Feb. 1989 21 p Presented at the Symposium on the Construction of Stable Numerical Methods for Differential and Integral Equations, Amsterdam, Netherlands, 29 Mar. 1989 Submitted for publication
(CWI-NM-R8907; ETN-90-96735) Copyright Avail: NTIS HC A03/MF A01

The Runge-Kutta-Chebyshev method is an s-stage Runge-Kutta method designed for explicit integration of stiff systems of ordinary differential equations originating from spatial discretization of parabolic partial differential equations. The method possesses an extended real stability interval with a length beta proportional to s to the 2nd power. It can be applied with s arbitrary large. The involved stability property here is internal stability. Full convergence properties of a class of 1st and 2nd order schemes are considered. Full convergences means convergence of the fully discrete solution to the solution of the partial differential equation upon simultaneous space-time grid refinement. Convergence is proven under the sole condition that the necessary time-step restriction for stability is satisfied. The error bounds are valid for any s and independent of the stiffness of the problem. Numerical examples are given. ESA

**N90-24039#** Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Numerical Mathematics.
**ITERATIVE DEFECT CORRECTION AND MULTIGRID ACCELERATED EXPLICIT TIME STEPPING SCHEMES FOR THE STEADY EULER EQUATIONS**
Marie-Helene Lallemand (Institut National de Recherche d'Informatique et d'Automatique, Valbonne, France ) and Barry Korren Apr. 1989 15 p Sponsored in part by CNES
(CWI-NM-R8908; ETN-90-96736) Copyright Avail: NTIS HC A03/MF A01

Analytical and experimental convergence results are presented for a pseudo-unsteady solution method for second-order accurate upwind discretizations of the Euler equations. Comparison with an existing pseudo-unsteady solution method are performed. Both methods make use of nonlinear multigrid for acceleration and nested iteration for the fine grid initialization. The method proposed uses iterative defect correction and has stability and smoothing properties. Numerical experiments are carried out. The method leads to both better convergence and efficiency. ESA

**N90-24040#** Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Numerical Mathematics.
**CONVERGENCE OF ONE-LEG MULTISTEP METHODS FOR STIFF NONLINEAR INITIAL VALUE PROBLEMS**
Willem H. Hundsdorfer Jun. 1989 17 p
(CWI-NM-R8911; ETN-90-96738) Copyright Avail: NTIS HC A03/MF A01

Global error bounds are derived for multistep schemes applied to classes of arbitrarily stiff, nonlinear value problems. It is shown that stable one-leg methods are convergent for stiff problems with the same order as for nonstiff problems, provided that the stepsize variation is sufficiently regular. Using an equivalence relation between one-leg and linear multistep methods, convergence results for linear multistep methods on uniform grids are obtained. ESA

**N90-24041#** Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Numerical Mathematics.
**LOCAL AND GLOBAL ORDER REDUCTION OF SOME LOD SCHEMES**
Willem H. Hundsdorfer Jul. 1989 13 p Presented at the 5th International Seminar on Numerical Treatment of Differential Equations, Halle, Fed. Republic of Germany, 22-26 May 1989
(CWI-NM-R8914; ETN-90-96741) Copyright Avail: NTIS HC A03/MF A01

The convergence properties of two Locally One Dimensional (LOD) methods, applied to linear parabolic initial boundary values problems, are discussed. Unconditional convergence for partial differential equations is discussed. Discretization in space of partial differential equation problems leads to large systems of ordinary differential equations. The discretization errors of the LOD schemes is analyzed for parabolic model problems. Some error bounds are presented and it is shown that they are valid uniformly in the meshwidth in space. ESA

**N90-24042#** Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Analysis, Algebra and Geometry.
**REFLEXIVITY, THE DUAL RADON-NYKODYM PROPERTY, AND CONTINUITY OF ADJOINT SEMIGROUPS**
J. M. A. M. vanNeerven Jun. 1989 17 p
(CWI-AM-R8908; ETN-90-96742) Copyright Avail: NTIS HC A03/MF A01

For certain Banach space, characterizations of reflexivity and the dual Radon-Nykodym property are given in terms of continuity of adjoint semigroups. It is shown that a weak-continuous semigroup on a dual Banach space with the Radon-Nykodym property is strongly continuous for t greater than zero. Shauder decomposition and nonshrinking bases in the nonreflexive space are considered. Some applications outside the semigroup theory are given. ESA

**N90-24043#** Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Analysis, Algebra and Geometry.
**POLYNOMIAL ASYMPTOTIC ESTIMATES OF GEGENBAUER, LAGUERRE, AND JACOBI POLYNOMIALS**
N. M. Temme Jul. 1989 22 p Presented at the International Symposium on Asymptotic and Computational Analysis, Winnipeg, Manitoba, 5-7 Jun. 1989
(CWI-AM-R8911; ETN-90-96744) Copyright Avail: NTIS HC A03/MF A01

Asymptotic forms of P to the (alpha, beta)th power (P, L and C are of degree n and a function of x), the Jacobi, Laguerre and Gegenbauer polynomials are discussed. The Gegenbauer polynomial and Laguerre polynomial are approximated in terms of Hermite polynomials, the Jacobi polynomial in terms of a Gegenbauer polynomial and a Laguerre polynomial. Some results for Laguerre polynomials and Gegenbauer polynomials are discussed. New results for the Jacobi polynomials are announced. A complete treatment with proofs for the new cases is considered. The results are obtained by using Liouville Green transformations of differential equations defining the orthogonal polynomials. ESA

**N90-24044#** Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Analysis, Algebra and Geometry.
**MORPHOLOGICAL SAMPLING**
H. J. A. M. Heijmans and A. Toet (Institute for Perception RVO-TNO, Soesterberg, Netherlands ) Aug. 1989 35 p
(CWI-AM-R8913; ETN-90-96745) Copyright Avail: NTIS HC A03/MF A01

A sampling strategy for grey-level functions based on mathematical morphology is presented. Flexible sampling strategies are required for the construction of multiresolution image representations like pyramids and quad-trees. The sampling operator considered is a dilation. A number of different algorithms to reconstruct an image from its sampled version are presented. It is shown that a reconstruction which dominates the original image is obtained by application of the adjoint erosion. ESA

**N90-24045#** Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Operations Research, Statistics, and System Theory.
**ON RATES OF CONVERGENCE AND ASYMPTOTIC NORMALITY IN THE MULTIKNAPSACK PROBLEM**
Sara A. vandeGeer and Leen Stougie (Amsterdam Univ., Netherlands ) Jul. 1989 11 p
(CWI-BS-R8912; ETN-90-96749) Copyright Avail: NTIS HC A03/MF A01

An almost sure asymptotic characterization, derived for the optimal solution of the Knapsack capacities, is reviewed. Such derivations were carried out when the profit and requirement coefficients of items to be selected from are random variables. A rate of convergence and asymptotic normality for this process using results from the theory of empirical processes is established. It is shown that the results from empirical process theory can be used to derive a central limit theorem. The results and the role that the application of empirical process theory may play in this field of research are discussed. ESA

**N90-24046#** Utrecht State Univ. (Netherlands). Dept. of Computer Science.
**ON MODELS FOR PROPOSITIONAL DYNAMIC LOGIC**
P. M. W. Knijnenburg and Jan vanLeeuwen Feb. 1989 25 p
(RUU-CS-89-3; ETN-90-96768) Avail: NTIS HC A03/MF A01

Some foundational aspects of the theory of Propositional Dynamic Logic (PDL) are discussed. The existence of a Kripke model U that is universal in the sense that every other Kripke model M can be isomorphically embedded in it is proven. Using this model, different and easy proofs of the completeness theorem for the Segerberg axiomatization of PDL and the small model theorem are given. An infinitary axiomatization for PDL is proven using a syntax model A, by a technique from modal logic. It is also proven that U and A are isomorphic and show that the characteristic algebra of U is initial in the class of star-continuous dynamic algebras. ESA

**N90-24047#** Wisconsin Univ., Madison. Center for Mathematical Sciences.
**A VARIATIONAL APPROACH TO HETEROCLINIC ORBITS FOR A CLASS OF HAMILTONIAN SYSTEMS Technical Summary Report**
Paul H. Rabinowitz Feb. 1990 17 p
(Contracts DAAL03-87-K-0043; N00014-88-K-0134; NSF MCS-81-10556)
(AD-A219853; CMS-TSR-90-20) Avail: NTIS HC A03/MF A01 CSCL 12/2

A large literature has developed in the last decade in which methods from the calculus of variations have been used to prove the periodic solutions of Hamiltonian systems of ordinary differential equations. The recent monograph of Mawhin and Willem provides a sizable bibliography of such works. Aside from equilibria, periodic solutions are the simplest global in time solutions of differential equations. It is only within the past one or two years that attempts have begun to extend the variational approach to such systems to find other kinds of global solutions of Hamiltonian systems. Thus far mainly homoclinic orbits have been treated. However, heteroclinic orbits were studied in an earlier work by the author, entitled Periodic and Heteroclinic orbits for a Periodic Hamiltonian system, for the class of second order Hamiltonian systems. The author's goal in this paper is to extend one of the main results in his earlier work mentioned above. GRA

**N90-24048#** Naval Postgraduate School, Monterey, CA.
**APPROXIMATE INTERVAL ESTIMATION METHODS FOR THE RELIABILITY OF SYSTEMS USING COMPONENT DATA WITH EXPONENTIAL AND WEIBULL DISTRIBUTIONS M.S. Thesis**
Hyeon-Soo Lee Sep. 1989 64 p
(AD-A219857) Avail: NTIS HC A04/MF A01 CSCL 12/3

Two approximate parametric interval estimation methods for reliability using component test data are developed and evaluated. One method can be applied to any coherent system with components which have exponential failure times with possibly different failure rates and different mission operating times. This method estimates the ratios of component failure rates which are then used to develop the approximate lower confidence limit. These ratio estimates are developed with and without jackknife methods and the two results are compared. This procedure is very accurate and simple to compute, requiring the use of standard chi-squared tables. This ratio method is subsequently extended to coherent systems with components whose failure times have a Weibull distribution. A nearly exact parametric lower confidence limit for P(X is greater than x) is developed and evaluated where x is given and X has a normal distribution with unknown mean and variance. GRA

**N90-24049#** New York Univ., New York. Inst. of Mathematical Sciences.
**DIFFRACTION PATTERNS AND VORTEX ROLLUP Final Report, 1 Nov. 1987 - 31 Oct. 1989**
J. Glimm 31 Oct. 1989 9 p
(Grant AF-AFOSR-0025-88; AF Proj. 2304)
(AD-A219876; AFOSR-90-0335TR) Avail: NTIS HC A02/MF A01 CSCL 12/1

The three main developments concern: Riemann problems and nonlinear wave interactions for real materials, including material strength properties; Riemann problems and chaotic mixing for conversation laws in general; and development of three dimensional and parallel processing front tracking algorithms. GRA

**N90-24050#** Maryland Univ., Baltimore. Dept. of Mathematics.
**A FEEDBACK EXTENSION TO THE NUMERICAL SOLUTION OF NONLINEAR BOUNDARY VALUE PROBLEMS**
Soren Jensen 1990 3 p
(Contracts N00014-85-K-0169; N00014-87-K-0427)
(AD-A219886) Avail: NTIS HC A01/MF A01 CSCL 12/1

A feed-back extension procedure is developed for the numerical solution of a class of nonlinear boundary value problems associated with anti-plane shear or Hencky's theory of plasticity. This extends previous results using dimensional reduction in energy-asymptotic format. GRA

**N90-24051#** Maryland Univ., Baltimore. Dept. of Mathematics.
**AN H(m)SUB 0 INTERPOLATION RESULT**
Soren Jensen 14 Nov. 1989 8 p
(Contract N00014-87-K-0427)
(AD-A219888) Avail: NTIS HC A02/MF A01 CSCL 12/1

A proof is presented for interpolation results related to the approximation theory for higher order finite element or spectral methods when C superscript 1 (or higher) regularity is convenient for the finite dimensional subspaces. This can be a natural choice for example for Stokes problem, the biharmonic problem or higher order-plate- and shell models. It is shown that the same intermediate spaces is gotten whether one interpolates between two Sobolev spaces defined on a domain with nonsmooth boundary first and then enforces the homogeneous boundary conditions afterwards or interpolates between two Sobolev spaces where the homogeneous boundary conditions are enforced throughout the interpolation process. GRA

**N90-24052#** Maryland Univ., Baltimore. Dept. of Mathematics.
**COMPUTATIONAL ASPECTS OF ADAPTIVE DIMENSIONAL REDUCTION FOR NONLINEAR BOUNDARY VALUE PROBLEMS**
Soren Jensen 24 Feb. 1990 10 p
(Contracts N00014-85-K-0169; N00014-87-K-0427)
(AD-A219889) Avail: NTIS HC A02/MF A01 CSCL 12/1

There is increased interest recently in feed-back methods for reliable, robust, efficient computational methods in mechanics. The construction of such methods is outlined for a class of problems describing special (anti-plane shear) deformations of bars of rectangular or arched cross section. In particular, it is shown how to reduce the dimension of the underlying problem adaptively . For brittle or linear materials, this method is adaptive (optimal in rate of convergence). The emphasis is on the computational aspects that have practical import to the performance of this method, such as the construction of a posteriori error estimators that are simple to compute, the selection of basis functions in the dimensional reduction and the heuristic principle for extension. These concepts are illustrated s with computations. GRA

**N90-24053#** North Carolina Univ., Chapel Hill. Center for Stochastic Processes.
**M-ESTIMATORS IN LINEAR MODELS WITH LONG RANGE DEPENDENT ERRORS**
Hira L. Koul Feb. 1990 24 p Prepared in cooperation with Michigan State Univ., East Lansing
(Contract F49620-85-C-0144; AF Proj. 2304)
(AD-A219921; TR-283; AFOSR-90-0326TR) Avail: NTIS HC A03/MF A01 CSCL 12/3

This note discusses the asymptotic behavior of a class of M-estimators in linear models which errors are Gaussian, or a function of Gaussian random variables, that are long range dependent. The asymptotics are discussed when the design variables are either independent identically distributed (IID) or long range dependent, independent of the errors, or known constants. It is observed that the class of M-estimators of the regression parameter vector corresponding to skew symmetric scores and symmetric errors asymptotically behave like the least squares estimators. Moreover, in these cases, if the design variables are either IID or known constants then the limiting distributions are Normal. But if the design variables are also long range dependent then the limiting distributions are nonnormal. GRA

**N90-24054#** Admiralty Research Establishment, Portland (England).
**A NOTE ON THE GAUSSIAN INTEGRATION FORMULA**
C. Richardson Aug. 1989 12 p
(AD-A220053; ARE-TM(UDT)-89114; DRIC-BR-113133) Avail: NTIS HC A03/MF A01 CSCL 12/3

The Gaussian integration method is described together with the 2-point implementation for numerical integration. A FORTRAN program is given and the result of a test example. This work was originally completed some years ago and the software, which is incorporated in a Maths Library on the UDT computer facility, was used extensively. Gauss' formula provides a method for calculating the definite integral of a given function. GRA

**N90-24055#** Clemson Univ., SC.
**THE CLEMSON UNIVERSITY, UNIVERSITY RESEARCH INITIATIVE PROGRAM IN DISCRETE MATHEMATICS AND COMPUTATIONAL ANALYSIS Final Report**
Mar. 1990 44 p
(Contract N00014-86-K-0693)
(AD-A220103) Avail: NTIS HC A03/MF A01 CSCL 12/1

Clemson University created in September 1986 a University Research Initiative Program in Discrete Mathematics and Computational Analysis funded by ONR to investigate basic and applied problems in two interdisciplinary areas of the Mathematical Sciences and established an advanced computing facility to support computational research in these areas. The research focused on the areas of discrete mathematics and computational analysis. Some problems addressed have a strong potential for application into technological developments at the Navy laboratory level. Other problems address basic theoretical questions that are important to the long-term scientific interest of the Navy and support subsequent applied research of the Program. Faculty research efforts were augmented by visitors and graduate students. GRA

**N90-24056#** David Taylor Research Center, Bethesda, MD. Dept. of Ship Structures and Protection.
**A FAST PC-BASED SOLVER FOR SIMULTANEOUS LINEAR EQUATIONS Research and Development Report**
Peter N. Roth Jan. 1990 51 p
(AD-A220190; DTRC/SSPD-90-175-14) Avail: NTIS HC A04/MF A01 CSCL 12/5

An indirect (pointer-based) datastructure for the storage of a symmetric, positive definite matrix of coefficients, and the corresponding right hand side vector is presented. This datastructure is useful in many kinds of engineering work, most notably finite element analysis. Procedures for accessing the datastructure are demonstrated via the small Turbo Pastcal program KxR. Matrix methods in general, and the finite element method (FEM) in particular, are now common engineering tools. GRA

**N90-24057#** Maryland Univ. Baltimore County, Catonsville. Dept. of Mathematics and Statistics.
**BEHAVIOUR IN THE LARGE OF NUMERICAL SOLUTIONS TO ONE-DIMENSIONAL NONLINEAR VISCOELASTICITY BY CONTINUOUS TIME GALERKIN METHODS**

Donald A. French (Carnegie-Mellon Univ., Pittsburgh, PA.) and Soren Jensen 5 Feb. 1990 25 p
(Contracts N00014-87-K-0427; N00014-90-J-1238; NSF DMS-88-02828)
(AD-A220197; AD-E900542) Avail: NTIS HC A03/MF A01 CSCL 12/3

We analyze the long time behavior of fully discrete solutions to a one-dimensional nonlinear viscoelastic problem. It is shown that these approximations which are found by a continuous time Galerkin method converge to a steady state. The possible numerical steady states are characterized and in particular their high degree of dependence on initial data and mesh design is explained. Computational results are included which show the above dependence and indicate that the numerical solutions will typically not converge to unstable states. GRA

**N90-24058*#** North Carolina State Univ., Raleigh. Mars Mission Research Center.
**COMPUTATIONAL TOOLS FOR MULTI-LINKED FLEXIBLE STRUCTURES**
Gordon K. F. Lee, Thomas A. Brubaker, and James R. Shults (Colorado State Univ., Fort Collins.) 2 Jul. 1990 36 p
(Grant NAG1-926)
(NASA-CR-186139; NAS 1.26:186139) Avail: NTIS HC A03/MF A01 CSCL 12A

A software module which designs and tests controllers and filters in Kalman Estimator form, based on a polynomial state-space model is discussed. The user-friendly program employs an interactive graphics approach to simplify the design process. A variety of input methods are provided to test the effectiveness of the estimator. Utilities are provided which address important issues in filter design such as graphical analysis, statistical analysis, and calculation time. The program also provides the user with the ability to save filter parameters, inputs, and outputs for future use. Author

**N90-24059*#** Cornell Univ., Ithaca, NY. Dept. of Computer Science.
**FAST CASUAL MULTICAST**
Kenneth Birman, Andre Schiper (Ecole Polytechnique Federale de Lausanne, Switzerland ), and Pat Stephenson 10 Apr. 1990 33 p
(Contract NAG2-593; N00140-87-C-8904; ARPA Order 6037)
(NASA-CR-186643; NAS 1.26:186643) Avail: NTIS HC A03/MF A01 CSCL 12A

A new protocol is presented that efficiently implements a reliable, causally ordered multicast primitive and is easily extended into a totally ordered one. Intended for use in the ISIS toolkit, it offers a way to bypass the most costly aspects of ISIS while benefiting from virtual synchrony. The facility scales with bounded overhead. Measured speedups of more than an order of magnitude were obtained when the protocol was implemented within ISIS. One conclusion is that systems such as ISIS can achieve performance competitive with the best existing multicast facilities--a finding contradicting the widespread concern that fault-tolerance may be unacceptably costly. Author

**N90-24060#** Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Operations Research, Statistics, and System Theory.
**APPLICATIONS OF POLYHEDRAL COMBINATORICS TO MULTICOMMODITY FLOWS AND COMPACT SURFACES**
A. Schrijver Oct. 1989 25 p
(CWI-BS-R8921; ETN-90-96795) Copyright Avail: NTIS HC A03/MF A01

A survey of some recent results on multicommodity flows and compact surfaces, derived with the help of methods from polyhedral combinatorics, is presented. For several of the results obtained, no other proof method than polyhedral methods is known. The methods used are variants of Farkas' lemma. The first method is applied to graphs embedded on the Klein bottle and the second to graphs embedded on compact orientable surfaces. Results on planar multicommodity flows are derived. ESA

**N90-24061#** Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Operations Research, Statistics, and System Theory.
**SHORT PROOFS ON MULTICOMMODITY FLOWS AND CUTS**
A. Schrijver Oct. 1989 13 p
(CWI-BS-R8922; ETN-90-96796) Copyright Avail: NTIS HC A03/MF A01

A short proof of a theorem of Karzanov on the packing of cuts is given. A theorem of Lomonosov on the existence of integer multicommodity flows (implying theorems of Hu, Rothschild and Whinston, Dinits, Papernov, and Seymour) is derived. ESA

**N90-24062#** Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Operations Research, Statistics, and System Theory.
**DISJOINT HOMOTOPIC PATHS AND TREES IN A PLANAR GRAPH**
A. Schrijver Oct. 1989 65 p
(CWI-BS-R8923; ETN-90-96797) Copyright Avail: NTIS HC A04/MF A01

A polynomial-time algorithm for a given problem is described. A theorem characterizing the existence of a solution to this problem is proved. The algorithm is extended to disjoint homotopic trees. A corollory is derived. ESA

**N90-24063#** Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Software Technology.
**ARITHMETIC CLASSIFICATION OF PERFECT MODELS OF STRATIFIED PROGRAMS (EXTENDED VERSION)**
Krzysztof R. Apt and Howard A. Blair (Syracuse Univ., NY.) Jul. 1989 20 p Submitted for publication
(CWI-CS-R8928; ETN-90-96799) Copyright Avail: NTIS HC A03/MF A01

The recursion theoretic complexity of the perfect (Herbrand) models of stratified logic programs is studied. These models are shown to lie arbitrarily high in the arithmetic hierarchy. As a byproduct, a similar characterization of the recursion theoretic complexity of the set of consequences in a number of formalisms for non-monotonic reasoning is obtained. Under some circumstances this complexity is shown to be brought down to recursiveness and recursive enumerability. To this purpose, a class of recursion-free programs are studied. ESA

**N90-24064#** Universiteit Twente, Enschede (Netherlands). Faculty of Applied Mathematics.
**A GENERALIZATION OF ORE'S THEOREM INVOLVING NEIGHBORHOOD UNIONS**
H. J. Broersma, J. vandenHeuvel, and H. J. Veldman Nov. 1989 16 p
(MEMO-825; ISSN-0169-2690; ETN-90-96830) Avail: NTIS HC A03/MF A01

Where G is a graph of order n, then settling conjectures of Chen and Jackson, the following generalization of Ore's theorem is proved: if G is two connected and with given conditions for every pair of nonadjacent vertices u, v, then either G is Hamiltonian, or G is the Petersen graph, or G belongs to one of three families of exceptional graphs of connectivity two. Several other theorems are given and considered. ESA

**N90-24065#** Universiteit Twente, Enschede (Netherlands). Faculty of Applied Mathematics.
**REMARKS ON HAMILTONIAN PROPERTIES OF CLAW-FREE GRAPHS**
A. Ainouche, H. J. Broersma, Shi Ronghua (East China Inst. of Tech., Nanjing.), and H. J. Veldman Nov. 1989 16 p Sponsored by Chinese National Scientific Funds
(MEMO-829; ISSN-0169-2690; ETN-90-96834) Avail: NTIS HC A03/MF A01

Zhang's proof of Hamiltonian properties of claw-free graphs is shown to establish a stronger result of Chvatal-Erdos type: if G is a k-connected claw-free graph (k greater than or equal to 2) such that the square G squared contains no independent set of $k+1$ vertices, then G is Hamiltonian. The following analog is established:

if G is a k-connected claw-free graph such that G squared contains no independent set of k+2 vertices, then G is traceable. Other results of Zhang are generalized by showing that a claw-free graph G of order at least 3 is vertex pancyclic if every vertex cut of G contains a vertex v such that the neighbors of v induce a connected subgraph of G. ESA

**N90-24066#** Universiteit Twente, Enschede (Netherlands). Faculty of Applied Mathematics.
**OPTIMIZATION AND OPTIMALITY TEST FOR THE MAX-CUT PROBLEM**
C. Hohmann and W. Kern Dec. 1989 17 p
(MEMO-830; ISSN-0169-2690; ETN-90-96835) Avail: NTIS HC A03/MF A01

The following two problems are polynomially equivalent: given a (weighted) graph G, and a cut C of G, decide whether C is maximal or not; given a (weighted) graph G, and a cut C of G, decide whether C is maximal or not, and in case it is not, find a better solution C'. As a consequence, an optimality testing oracle may be used to design a polynomial time algorithm for approximately solving the (weighted) max-cut problem. This in turn implies that recognizing optimal cuts in an unweighted graph is NP-hard. ESA

**N90-24067#** Universiteit Twente, Enschede (Netherlands). Faculty of Applied Mathematics.
**GRAPH REPRESENTATION IN A SPECIAL FAMILY OF INFINITE GRAPHS**
Hansjoachim Walther Dec. 1989 13 p
(MEMO-831; ISSN-0169-2690; ETN-90-96836) Avail: NTIS HC A03/MF A01

The following problem is addressed: let G be any finite undirected graph; find a set v asterisk (G) of natural numbers with minimum size, and an infinite undirected graph with the vertex set being the set of all integrers and the edge set as defined, such that the infinite undirected graph contains an induced subgraph H isomorphic to G. For some classes of graphs G, the exact value of (v asterisk (G)) is given and for some other classes the upper or lower bounds for (v asterisk) are found. ESA

**N90-24068#** Universiteit Twente, Enschede (Netherlands). Faculty of Applied Mathematics.
**ON A PROBLEM OF F. RUSKEY**
F. Goebel Dec. 1989 9 p
(MEMO-832; ISSN-0169-2690; ETN-90-96837) Avail: NTIS HC A02/MF A01

The following conjecture is addressed: let Q be a partial order, and let the graph G(Q) be defined as the graph with the set of linear extensions of Q as point set, while two points of G(Q) are adjacent if and only if the corresponding permutations differ by one transposition. It is of interest to know for which Q the (bipartite) graph G(Q) has a Hamilton-path. It is shown that G(Q) has even a Hamilton-cycle when Q contains 2 isolated points. The sizes of the bipartite classes of G(Q) are determined when Q is the union of two total orders. ESA

**N90-24069#** Universiteit Twente, Enschede (Netherlands). Faculty of Applied Mathematics.
**DYNAMIC DISTURBANCE DECOUPLING FOR NONLINEAR SYSTEMS**
H. J. C. Huijberts, H. Nijmeijer, and L. L. M. vanderWegen Dec. 1989 25 p
(MEMO-835; ISSN-0169-2690; ETN-90-96840) Avail: NTIS HC A03/MF A01

In analogy with the dynamic input-output decoupling problem the dynamic disturbance decoupling problem for nonlinear systems is introduced. A local solution of this problem is obtained in the case that the system under consideration is invertible. The solution is given in algebraic as well as in geometric terms and shows that the problem forms a proper extension of the standard (static) disturbance decoupling problem. The theory is illustrated by means of two examples: a mathematical one and the example of a voltage frequency controlled induction motor. ESA

**N90-24070#** Universiteit Twente, Enschede (Netherlands). Tele-Informatics Group.
**CONSTRAINT-ORIENTED SPECIFICATION IN A CONSTRUCTIVE FORMAL DESCRIPTION TECHNIQUE**
Ed Brinksma Nov. 1989 30 p Sponsored in part by EEC and Netherlands Ministry of Education and Sciences
(Memo-INF-89-44; ISSN-0923-1714; ETN-90-96841) Avail: NTIS HC A03/MF A01

Constraint-oriented specification is a style that can be used in some process algebraic formalism to implement the power of a logical conjunction. Although this type of conjunction is usually limited to properties of traces, and therefore to the safety aspects of a specification, it turns out to be an extremely useful tool in realistic applications, where it is used to carry out the successive steps of logical refinement in specifications. This specification style is explained and examples of its use in the specification languages LOTOS are given. A proposal for a sophistication of the forms of parallel composition and abstraction (hiding) that are used to improve the large scale applicability of this style of specification is given. An example of their use and other, related uses of the new operators, are discussed. ESA

**N90-24071#** Technische Univ., Berlin (Germany, F.R.). Inst. fuer Luft- und Raumfahrt.
**STABILITY AND STABILITY SENSITIVITY BY PERIODICALLY TIME DEPENDENT SYSTEMS: HILL VERSUS FLOQUET [STABILITAET UND EMPFINDLICHKEIT DER STABILITAET BEI PERIODISCH ZEITVARIANTEN SYSTEMEN HILL VERSUS FLOQUET]**
M. Person and M. Wiedemann Jul. 1989 34 p In GERMAN Sponsored by DFG
(ILR-Mitt-221(1989); ETN-90-96479) Avail: NTIS HC A03/MF A01

Technical systems described by periodical time variant equations of motion sometimes show an unstable behavior at certain constellations of parameters without an external excitation. This phenomenon is studied by a transfer matrix on a period, by means of an integration process and the Runge-Kutta-Gill method. A second process is used, which puts the system in a time independent system of theoretically unfinite size. A method to analyze the changes of the stability behavior is presented, for the case where the parameters of the system are varied, without completly again analyzing the stability. A practical example of two one-wing wind turbines with oscillating articulation showed good results in accuracy and calculation time. ESA

**N90-24072#** Utrecht State Univ. (Netherlands). Dept. of Computer Science.
**A GENERAL APPROACH TO DOMINANCE IN THE PLANE**
Mark T. deBerg, Svante Carlsson (Lund Univ., Sweden ), and Mark H. Overmars Nov. 1988 24 p Sponsored in part by Netherlands Organization for Scientific Research
(Grant NFR-8992-100)
(RUU-CS-88-35; ETN-90-96857) Avail: NTIS HC A03/MF A01

Problems of direct dominance and rectangular visibility are studied. An algorithm is presented that solves the problem in optimal time 0(n log n plus k) where n is the size of P upsilon 0 and k is the number of answers. A second problem asks to store the set of P and O such that queries of the form given a query point q, compute all points p in P, such that q dominates p with respect to O can be answered efficiently. The notion of dominance with respect to obstacles is extended to obstacle sets that may contain arbitrary objects. ESA

**N90-24073#** Utrecht State Univ. (Netherlands). Dept. of Computer Science.
**EFFICIENT MOTION PLANNING FOR AN L-SHAPED OBJECT**
D. Halperin, Mark H. Overmars, and M. Sharir (Tel-Aviv Univ., Israel ) Dec. 1988 40 p Sponsored in part by Digital Equipment Corp.; IBM; United States-Israel Binational Science Foundation; National Council for Research and Development, Tel-Aviv, Israel; and Israel Academy of Sciences and Humanities, Jerusalem

(Contract N00014-87-K-0129; NSF DCR-83-20085)
(RUU-CS-88-38; ETN-90-96859) Avail: NTIS HC A03/MF A01

An algorithm is presented to solve a motion planning problem involving an L shaped body L and a two dimensional region with n point obstacles. The algorithm is used to help decide whether there is a continuous motion connecting two given positions and orientations of L during which L avoids collision with obstacles. The algorithm is a variant of the cell-decomposition technique of the configuration space but it employs a technique for obtaining a compact representation of the free space which results in a saving of an ordrer of magnitude. The approach used in the algorithm seems applicable to motion planning of robotic arms whose spaces of free placement have a structure similar to that of the L shaped body. ESA

**N90-24074#** Technische Univ., Delft (Netherlands).
**SPARSE APPROXIMATIONS OF INVERSE MATRICES Ph.D. Thesis**
Hendrik Willem Nelis Oct. 1989 112 p
(ETN-90-96904) Avail: NTIS HC A06/MF A01

The use of techniques from inverse scattering theory such as the Wiener-Hopf factorization and the Schur algorithm in the determination of an optimal or suboptimal sparse approximation to the inverse of a positive definite matrix is shown. Only entries in the original matrix that correspond to nonzero entries in the approximation are used. The algorithms proposed have a complexity that is proportional to the number of these nonzero entries. Parasitic capacitances in a large integrated circuit are modeled. An accurate model for a system with a large number of conductors is obtained which demonstrates the power of the methods proposed. ESA

**N90-24075#** Amsterdam Univ. (Netherlands). Inst. for Language, Logic and Information.
**THE FINE-STRUCTURE OF CATEGORIAL SEMANTICS**
Johan vanBenthem Dec. 1988 58 p Revised
(ITLI-LP-89-01; ETN-90-96907) Avail: NTIS HC A04/MF A01

A categorial grammar is used as a framework to demonstrate the correspondence of semantics to a fine-structure. Standard type-theoretical semantics are presented with emphasis on the general semantic questions about natural language engendered. The fine-structure perspective is elaborated. Some variations on the standard approach are reviewed in order to show how the concerns and methods so far transfer to more complex modelings of linguistic phenomena. Further technical background material collected is included. ESA

**N90-24076#** Amsterdam Univ. (Netherlands). Inst. for Language, Logic and Information.
**DYNAMIC PREDICATE LOGIC: TOWARDS A COMPOSITIONAL, NON-REPRESENTATIONAL SEMANTICS OF DISCOURSE**
Jeroen Groenendijk and Martin Stokhof Jul. 1989 57 p Revised
(ITLI-LP-89-02; ETN-90-96908) Avail: NTIS HC A04/MF A01

The formulation and investigation of a dynamic semantic interpretation of the language of first order predicate logic is presented. The resulting system, a dynamic predicate logic, is intended as a step towards a compositional, nonrepresentational theory of discourse semantics. Elements of dynamic interpretation are introduced heuristically. Prospects for further developments are indicated. ESA

**N90-24077#** Amsterdam Univ. (Netherlands). Inst. for Language, Logic and Information.
**TWO-DIMENSIONAL MODAL LOGICS FOR RELATIONAL ALGEBRAS AND TEMPORAL LOGIC OF INTERVALS**
Yde Venema Aug. 1989 76 p
(ITLI-LP-89-03; ETN-90-96909) Avail: NTIS HC A05/MF A01

Relation algebras and temporal logic of intervals are studied from a two dimensional modal logic viewpoint, and an attempt at finding analogous and/or new results is made. Two systems of generalized modal logics are defined: CC, characterizing frames and correspondence; and CDT, a modal logic chopping intervals. Connections between CC, CDT, and other logics are described. Two completeness theorems for two dimensional subsystems of CC are given. ESA

**N90-24078#** Amsterdam Univ. (Netherlands). Inst. for Language, Logic and Information.
**INTENSIONAL LAMBEK CALCULI: THEORY AND APPLICATION**
Andreja Prijatelj Oct. 1989 58 p
(ITLI-LP-89-06; ETN-90-96912) Avail: NTIS HC A04/MF A01

Metaproperties of intensional Lambek calculi are addressed. Montague's meaning postulates are analyzed by a Lambek-like mechanism in such a way as to show them superfluous. A better insight into phenomena of intensionalization is aimed at. A cut elimination theorem is proved and a decision procedure is established for a given deductive system. An auxiliary one-sorted system is constructed. A strategy for dynamically assigning an adequate interpretation to expressions of any given category is proposed and verified. ESA

**N90-24079#** Leiden Univ. (Netherlands). Dept. of Mathematics and Computer Science.
**CONTRACTIVITY OF RUNGE-KUTTA METHODS**
J. F. B. M. Kraaijevanger 1989 48 p Sponsored in cooperation with the Netherlands Organization for Scientific Research and the Royal Netherlands Academy of Sciences
(TW-89-12; ETN-90-96933) Avail: NTIS HC A03/MF A01

The necessary and sufficient conditions for Runge-Kutta methods to be contractive are discussed. Unconditional contractivity for arbitrary dissipative initial value problems, and conditional contractivity for initial value problems where the right hand side function satisfies a circle condition are discussed. The results are relevant for arbitrary norms, in particular for the maximum norm. The existence of an unique solution to the algebraic equations in each step is discussed. Contractive methods are shown to have a limited order of accuracy. Various optimal methods are presented. A numerical illustration of the theoretical events is provided by applying the method of lines to a parabolic and a hyperbolic partial differential equation. ESA

**N90-24080#** Leiden Univ. (Netherlands). Dept. of Mathematics and Computer Science.
**THE EXISTENCE OF SENSITIVE OPTIMAL POLICIES IN TWO MULTI-DIMENSIONAL QUEUEING MODELS**
Flos Spieksma 1989 24 p Sponsored by Netherlands Organization for Scientific Research
(TW-89-11; ETN-90-96932) Avail: NTIS HC A03/MF A01

The conditions for the existence of deterministic Blackwell optimal policies in denumerable Markov decision chains with unbounded rewards are discussed. These conditions include mu-uniform geometric recurrence. The mu-uniform geometric recurrence property implies the existence of average optimal policies. The value iteration algorithm for average rewards is shown to converge. The usefulness of the verification of mu-uniform geometric convergence in cases where average and alpha-discounted rewards are considered is discussed. ESA

**N90-24081#** Leiden Univ. (Netherlands). Dept. of Mathematics and Computer Science.
**NOTE ON THE OPTIMALITY OF THE GENERALIZED SHORTEST QUEUE POLICY**
Arie Hordijk and Ger Koole 1989 15 p
(TW-90-01; ETN-90-96934) Avail: NTIS HC A03/MF A01

A model consisting of m parallel servers, each with their own queue is discussed. Customers arrive according to an arrival process which generalizes the doubly stochastic Poisson process with a Markov environment. The system is controlled by assigning each incoming customer to one of the queues. The control may depend on the numbers of jobs present at the m servers. The service times are exponentially distributed with equal mean. Models with finite buffers and batch arrivals are considered. ESA

# 65 STATISTICS AND PROBABILITY

Includes data sampling and smoothing; Monte Carlo method; and stochastic processes.

**N90-24082*#** Research Inst. for Advanced Computer Science, Moffett Field, CA.
**BAYESIAN LEARNING**
Peter J. Denning 6 Mar. 1989 14 p
(Contract NCC2-387)
(NASA-CR-181528; NAS 1.26:181528; RIACS-TR-89.12) Avail: NTIS HC A03/MF A01 CSCL 12A

In 1983 and 1984, the Infrared Astronomical Satellite (IRAS) detected 5,425 stellar objects and measured their infrared spectra. In 1987 a program called AUTOCLASS used Bayesian inference methods to discover the classes present in these data and determine the most probable class of each object, revealing unknown phenomena in astronomy. AUTOCLASS has rekindled the old debate on the suitability of Bayesian methods, which are computationally intensive, interpret probabilities as plausibility measures rather than frequencies, and appear to depend on a subjective assessment of the probability of a hypothesis before the data were collected. Modern statistical methods have, however, recently been shown to also depend on subjective elements. These debates bring into question the whole tradition of scientific objectivity and offer scientists a new way to take responsibility for their findings and conclusions. Author

**N90-24083#** Illinois Univ., Champaign. Model Based Measurement Lab.
**FORMULA SCORING: BASIC THEORY AND APPLICATIONS Final Report**
Michael V. Levine Dec. 1989 55 p
(Contracts N00014-83-K-0397; N00014-86-K-0482; NR Proj. RR0-4204)
(AD-A218368; MEASUREMENT-SER-89-1) Avail: NTIS HC A04/MF A01 CSCL 12/3

Formula scoring is a systematic study of measurement statistics expressed as sums of products of item scores. The theory is currently being used to compute non-parametric estimates of ability distributions, item response functions, and option response functions. The theory was used to design algorithms for estimating item response functions from adaptive test data (on-line calibration), monitoring and correcting drift in observed score distributions for adaptive tests (on-line equating), computing optimal tests for cheating, and combining appropriateness measurement information from several subtests. A portion of the theory is developed from a few principles. Applications are considered to the problems of deciding whether ability has the same distribution in two demographic groups, to finding latent class models that are equivalent to item response models, and to controlling drift in adaptive testing programs. GRA

**N90-24084#** Michigan Univ., Ann Arbor. Dept. of Industrial and Operations Engineering.
**BOUNDING SEPARABLE RECOURSE FUNCTIONS WITH LIMITED DISTRIBUTION INFORMATION**
John R. Birge and Jose H. Dula (Southern Methodist Univ., Dallas, TX.) Jan. 1990 25 p
(Contract N00014-86-K-0628; NSF ECS-83-04065)
(AD-A219504; TR-90-1) Avail: NTIS HC A03/MF A01 CSCL 12/5

The recourse function in a stochastic program with recourse can be approximated by separable functions of the original random variables or linear transformations of them. The resulting bound them involves summing simple integrals. These integrals may themselves be difficult to compute or may require more information about the random variable than is available. It is shown that a special class of function has an easily computable bound that achieves the best upper bound when only first and second moment constraints are available. GRA

**N90-24085#** Naval Postgraduate School, Monterey, CA. Dept. of Operations Research.
**SAMPLE SIZE FOR CORRELATION ESTIMATES M.S. Thesis**
Kemal Salar Sep. 1989 86 p
(AD-A219810) Avail: NTIS HC A05/MF A01 CSCL 12/3

The classical measure of correlation (Pearson's R) and two nonparametric measures of correlation (Spearman's r and Kendall's tau) is examined with the goal of determining the number of samples needed to estimate a correlation coefficient with a 95 percent confidence level. For Pearson's R, tables, graphs, and computer programs are developed to find the sample number needed for a desired confidence interval size. Nonparametric measures of correlation (Spearman's r and Kendall's tau) are also examined for appropriate sample numbers when a specific confidence interval size desired. GRA

**N90-24086#** Harvard Univ., Cambridge, MA. Dept. of Statistics.
**THE TRICKETT-WELCH SOLUTION TO THE BEHRENS-FISHER PROBLEM APPLIED TO ONE-SIDED TOLERANCE LIMITS FOR RANDOM EFFECTS MODEL**
Mark G. Vangel (Army Materials Technology Lab., Watertown, MA.) Jan. 1990 58 p
(Contract N00014-86-K-0246)
(AD-A220416; TR-C-5-ONR) Avail: NTIS HC A04/MF A01 CSCL 12/3

One-sided tolerance limits for random effects models is a topic of considerable importance in engineering statistics. The purpose of this paper has been to consider this tolerance limit problem from the point of view of the Welch interpretation of the Behrens-Fisher problem. This approach leads to a method which provides essentially the nominal coverage probability whatever the value of the nuisance parameter. We have demonstrated that in addition to excellent coverage properties, the distribution of the proposed tolerance limit compares favorably with an existing procedure and with an exact solution for known nuisance parameter. GRA

**N90-24087#** Woods Hole Oceanographic Inst., MA.
**UNIVERSAL CRITERIA FOR BLIND DECONVOLUTION**
Ofir Shalvi and Ehud Weinstein Feb. 1990 53 p
(Contract N00014-90-J-1109)
(AD-A220853; WHOI-90-08) Avail: NTIS HC A04/MF A01 CSCL 09/1

Necessary and sufficient conditions for blind equalization/deconvolution (without observing the input) of an unknown, possible non-minimum phase linear time invariant system (channel) are presented. A family of optimization criteria is proposed and it is proven that their solutions correspond to the desired response. These criteria and the associated gradient-search algorithms, involve the computation of high order cumulants. The proposed criteria are universal in the sense that they do not impose any restrictions on the probability distribution of the input symbols. The problem of additive noise in the system is addressed and it is shown that in several important cases, e.g., when the additive noise is Gaussian, the proposed criteria are unaffected. GRA

**N90-24088#** Technische Univ., Delft (Netherlands). Faculty of Technical Mathematics and Informatics.
**EIGENVALUES OF DYNAMIC MAX-MIN SYSTEMS**
Geert Jan Olsder 1989 52 p
(Rept-89-84; ISSN-0922-5641; ETN-90-96684) Copyright Avail: NTIS HC A04/MF A01

Discrete event dynamic systems in which the time evolution depends on max and min operations simultaneously are studied. Specifically, necessary and sufficient conditions under which such systems have an eigenvalue and eigenvector(s) are given. Numerical algorithms to calculate these quantities are provided. The emphasis is on deterministic systems, but some stochastic extensions are given. From the modeling point of view, relations with timed Petri-nets are given. ESA

**N90-24089#** Technische Univ., Eindhoven (Netherlands). Dept. of Mathematics and Computing Science.
**THE GAMMA PROCESS AND THE POISSON DISTRIBUTION**
F. W. Steutel and J. G. F. Thiemann Sep. 1989 17 p
(MEMO-COSOR-89-24; ETN-90-96725) Avail: NTIS HC A03/MF A01

The problem of continuity corrections, in approximating a Poisson distribution by a normal one, is studied. A continuous variant of the Poisson distribution and gamma process are considered. The aim of the work is determining EK sub (j;n) and var k sub (j;n) from k sub 1 (mu),....,k sub n (mu), which has a Poisson distribution with mean mu. The gamma process and the approximation methods are presented. ESA

**N90-24090#** Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Operations Research, Statistics, and System Theory.
**ON A CLASS OF N-DIMENSIONAL ASSOCIATED RANDOM WALKS AND THE HITTING POINT IDENTITY**
J. W. Cohen Jul. 1989 37 p Sponsored by the Netherlands Organization for the Advancement of Research
(CWI-BS-R8911; ETN-90-96748) Copyright Avail: NTIS HC A03/MF A01

N-dimensional random walks on the lattice S with nonnegative integer valued coordinates in N-dimensional space are considered. They play an important role in the modeling of computer performance. For N greater than 2 the analysis of those random walks presents difficult analytical problems. The available techniques for N = 2 are hard to generalize for N greater than 2. An identity for the distribution of the hitting point of the bounding hyperplanes of S is derived. With the aid of this identity it is possible to construct a class of associated N-dimensional random walks on S which are accessible for detailed analysis. ESA

**N90-24091#** Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Operations Research, Statistics, and System Theory.
**PROBABILISTIC ANALYSIS OF THE MINIMUM WEIGHTED FLOWTIME SCHEDULING PROBLEM**
Alberto Marchetti Spaccamela, Wan Soo Rhee, Leen Stougie (Amsterdam Univ., Netherlands ), and Sara A. vandeGeer Jul. 1989 9 p Sponsored by Netherlands Organization for the Advancement of Research
(CWI-BS-R8913; ETN-90-96750) Copyright Avail: NTIS HC A02/MF A01

The minimum weighted flow time scheduling problem is studied from a probabilistic point of view. A probability distribution is specified over its problem instances. The asymptotics of the optimal solution value are derived. Rewriting this value as a U-statistic perturbed by a small term allows using results from the established theory on these statistics. A law of large numbers, a law of the iterated logarithm and a central limit theorem are derived. A proof of asymptotic optimality of a greedy heuristic is obtained for the solution of the NP-complete problem with more than one machine. ESA

**N90-24092#** Stanford Univ., CA. Dept. of Statistics.
**MEAN SQUARE ERROR BEHAVIOR FOR PREDICTION IN LINEAR REGRESSION MODELS**
Alan E. Gelfand 7 Mar. 1990 12 p
(Contract N00014-89-J-1627)
(AD-A219988; TR-427) Avail: NTIS HC A03/MF A01 CSCL 12/3

For the problem of individual prediction in linear regression models, that is, estimation of a linear combination of regression coefficients, mean square error behavior of a general class of adaptive predictors is examined. GRA

**N90-24093#** Ballistic Research Labs., Aberdeen Proving Ground, MD.
**EXTREME QUANTILE ESTIMATION IN BINARY RESPONSE MODELS Final Report**
Barry A. Bodt and Henry B. Tingey Mar. 1990 81 p
(AD-A220150; BRL-TR-3089) Avail: NTIS HC A05/MF A01 CSCL 12/3

Binary response models are used in estimating the probability, P(x), of a successful response when an experimental unit is exposed to a stimulus level, x. Frequently, the aim of the investigator is to locate a specific level of stimulus for which P(x) takes on a known value, p. The stimulus level sought, X sub 100 p, is referred to as the P sub th quantile of P(x). When p lies outside the interval (.25,.75), X sub 100 p is considered to be an extreme quantile. The focus is on the estimation of extreme X sub 100 p. All estimation techniques for extreme quantiles seek to limit estimate bias, lack of precision, and the importance of parametric assumption. The extreme quantile estimate described here utilizes, through a transformation of the responses, median estimation techniques where such problems are not so acute. The feasibility of the approach is demonstrated in a Monte Carlo study. It is shown that the design aspect of the approach has properties important to c-optimality, and it is argued that most data sets should be fit well by the modeled employed. This paper also explores the relationship is explored between data structure and the existence of maximum likelihood estimates in finite samples. GRA

**N90-24094#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**APPLICATIONS OF NON-PARAMETRIC DENSITY ESTIMATION Ph.D. Thesis**
Ahmed Mohamed Sultan 28 Feb. 1990 196 p
(AD-A220206; AFIT/DS/ENC/90-1) Avail: NTIS HC A09/MF A02 CSCL 12/3

The dissertation examines various methods of nonparametric density estimation, and nonparametric kernel estimation in more detail. The consequences of various kernel window width and their effect on the mean integrated square error are examined using Monte Carlo techniques. The mean and the variance of nonparametric density estimator is derived for symmetric kernels with finite mean and finite variance. The results also treat kernels with varying window parameters. The nonparametric kernel estimate was used to obtain new estimators for the three parameter Weibull distribution using distance estimation and the Cramer-von-Mises statistic. Comparison with maximum likelihood estimators using a Monte Carlo sample of size 1000 and various different parameters showed a significant improvement over the maximum likelihood estimators in the mean integrated square error between the estimated distribution and the true distribution. Several new goodness of fit tests are proposed using the nonparametric kernel estimator and the Cramer-von-Mises and the Anderson Darling statistics. Extensive Monte Carlo experiments were performed to obtain the critical values for the test and to study the power of the tests against eight alternative distributions. The tests using the Anderson Darling statistic showed greater power against almost all alternative distributions studied than the K.S. test. GRA

**N90-24095#** Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Operations Research, Statistics, and System Theory.
**ASSOCIATED DISTRIBUTIONS IN THE ANALYSIS OF TWO-DIMENSIONAL RANDOM WALKS**
J. W. Cohen Sep. 1989 21 p
(CWI-BS-R8917; ETN-90-96791) Copyright Avail: NTIS HC A03/MF A01

The analysis of two dimensional random walks on the lattice in the first quadrant of the set of real numbers sub 2, in particular if they are homogeneous is studied. Slight relaxation of the homogeneity condition soon leads to intricate analysis. By using so called associated distributions for the characterization of the transition structure of the random walk a quite general analysis becomes possible for a fairly large class of transition distributions. These associated distributions are introduced and their use in the derivation of the bivariate generating function of the stationary distribution of the random walk is exposed. ESA

**N90-24096#** Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Operations Research, Statistics, and System Theory.
**THE M/G/1 QUEUE WITH PERMANENT CUSTOMERS**
O. J. Boxma and J. W. Cohen Oct. 1989 15 p
(CWI-BS-R8919; ETN-90-96793) Copyright Avail: NTIS HC A03/MF A01

A simple variant of the classical M/G/1 queue is studied. It is an M/G/1 FCFS queue with two types of customers, ordinary customers who arrive according to a Poisson process, and permanent customers, who immediately return to the end of the queue after having received a service. The influence of the permanent customers on queue length and sojourn times of the Poisson customers is studied, using results from queueing theory and from the theory of branching processes. For the case that the service time distributions of the Poisson customers and all K permanent customers are negative exponential with identical means, it is shown that the queue length and sojourn time distributions of the Poisson customers are the (K+1)-fold convolution of those for the case without permanent customers. ESA

**N90-24097#** Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Operations Research, Statistics, and System Theory.
**STOCHASTICS REALIZATION PROBLEMS**
J. H. vanSchuppen Oct. 1989 43 p
(CWI-BS-R8920; ETN-90-96794) Copyright Avail: NTIS HC A03/MF A01

Stochastic realization problems are studied. The stochastic realization problem asks for the existence and the classification of all stochastic systems for which the output process equals a given process in distribution or almost surely. This is a fundamental problem of system and control theory. The stochastic realization problem is of importance to modeling by stochastic systems in engineering, biology, economics, etc. Several stochastic systems are mentioned for which the solution of the stochastic realization problem may be useful. As an example recent research on the stochastic realization problem for the Gaussian factor model and a Gaussian factor system is discussed. ESA

**N90-24098#** Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Software Technology.
**BELIEF NETWORKS IN PLAUSIBLE REASONING**
L. C. vanderGaag Jul. 1989 28 p
(CWI-CS-R8927; ETN-90-96798) Copyright Avail: NTIS HC A03/MF A01

The notion of a belief network as a formalism for representing a problem domain is introduced. Such a belief network consists of a qualitative part representing statistical variables and their probabilistic interrelationships, and a quantitative part representing a joint probability distribution on the problem domain. Two different schemes for reasoning with the belief network in which the qualitative part acts as an architecture for propagating evidence are discussed. A comparison of these network models with quasi-probabilistic models described is given. ESA

**N90-24099#** Leiden Univ. (Netherlands). Dept. of Mathematics and Computer Science.
**ON ERGODICITY AND RECURRENCE PROPERTIES OF A MARKOV CHAIN WITH AN APPLICATION TO AN OPEN JACKSON NETWORK**
Arie Hordijk and Flos Spieksma 1989 36 p Sponsored by Netherlands Organization for Scientific Research
(TW-89-10; ETN-90-96931) Avail: NTIS HC A03/MF A01

An overview of recurrence and ergodicity properties of a Markov chain is presented. Two notions of ergodicity and recurrence are introduced. They are called mu-geometric ergodicity and mu-geometric recurrence respectively. The first condition generalizes geometric as well as strong ergodicity. A key theorem is presented which shows that mu-geometric ergodicity is equivalent to weak mu-geometric recurrence. The latter condition is verified for the time-discretized two center open Jackson network. The corresponding two dimensional Markov chain is geometrically ergodic, but not strongly so. A consequence of mu-geometric ergodicity with mu of product form type is the convergence of the Laplace-Stieltjes transforms of the marginal distributions. ESA

**N90-24100#** Leiden Univ. (Netherlands). Dept. of Mathematics and Computer Science.
**A SOLUTION FOR THE VARIANCE-PENALIZED MARKOV DECISION PROBLEM BASED ON PARAMETRIC LINEAR PROGRAMMING**
Lodewijk C. M. Kallenberg Jan. 1990 17 p
(TW-90-02; ETN-90-96935) Avail: NTIS HC A03/MF A01

The Markov decision process with finite state and action spaces is considered. The average expected reward is appropriately modified to include a penalty for the variability in the stream of rewards. A pure and stationary policy is shown to minimize this criterion. A parametric linear programming problem which produces a list of candidates for such an optimal policy is presented. A procedure for determining the optimal policy is presented. The discounted case can be treated in the same way. ESA

# 66 SYSTEMS ANALYSIS

Includes mathematical modeling; network analysis; and operations research.

**N90-24101#** Cornell Univ., Ithaca, NY. Dept. of Computer Science.
**PRIORITY INVERSION AND ITS PREVENTION Interim Report**
Ozalp Babaoglu (Bologna Univ., Italy ), Keith Marzullo, and Fred B. Schneider Feb. 1990 30 p Sponsored in part by Digital Equipment Corp.
(Contracts N00014-86-K-0092; N00140-87-C-8904; NSF CCR-87-01103)
(AD-A218613; TR-90-1088) Avail: NTIS HC A03/MF A01 CSCL 12/4

A priority inversion occurs when a low-priority task causes execution of a higher-priority task to be delayed. The possibility of priority inversion complicates the analysis of systems that use priority-based schedulers because priority inversions invalidate the assumption that a task can be delayed only by higher-priority tasks. This paper formalizes priority inversion and gives sufficient conditions as well as some new protocols for preventing priority inversions. GRA

**N90-24102#** Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Operations Research, Statistics, and System Theory.
**SOJOURN TIMES IN QUEUEING NETWORKS**
O. J. Boxma and H. Daduna (Hamburg Univ., Germany, F.R. ) Aug. 1989 49 p Submitted for publication Sponsored by the Netherlands Organizaton for the Advancement of Research
(CWI-BS-R8916; ETN-90-96752) Copyright Avail: NTIS HC A03/MF A01

A survey of sojourn time results in queueing networks is presented. Particular attention is paid to product-form networks. Exact expressions for the joint distribution of a customer's successive sojourn times along a quasi overtake-free path are discussed. When the non-overtaking condition is violated, or when no product forms exists, few analytical results are known. Some of these results, and approximation techniques for product-form networks are given. For networks without product form, the emphasis is put on computational techniques and on general approximation methods adapted to the sojourn time problem. ESA

**N90-24103*#** Boeing Advanced Systems Co., Seattle, WA.
**IAPSA 2 SMALL-SCALE SYSTEM SPECIFICATION Final Report**
Gerald C. Cohen and Thomas C. Torkelson Mar. 1990 310 p

(Contract NAS1-18099)
(NASA-CR-182006; NAS 1.26:182006) Avail: NTIS HC A14/MF A02 CSCL 12B

The details of a hardware implementation of a representative small scale flight critical system is described using Advanced Information Processing System (AIPS) building block components and simulated sensor/actuator interfaces. The system was used to study application performance and reliability issues during both normal and faulted operation. Author

# 67 THEORETICAL MATHEMATICS

Includes topology and number theory.

**N90-24104#** Naval Postgraduate School, Monterey, CA.
**ITEM IDENTITIES AND THEIR RELATED OBSERVABLES**
Donald P. Gaver and Patricia A. Jacobs Nov. 1989 30 p
(AD-A219559; NPS55-90-03) Avail: NTIS HC A03/MF A01 CSCL 12/2

Each of J items has a characteristic Signature which varies in time. At time 0, the value of a Signature and the identity of the corresponding item are known. No further values of Signatures are observed until a later time t. At time t, a Signature from an unknown item is observed. The problem is to estimate the identity of the item whose Signature is observed at time t. The estimation procedure studied is to estimate the identity of the unknown item to be that one which maximizes the posterior probability of producing the observed Signature. GRA

**N90-24105#** Stanford Univ., CA. Systems Optimization Lab.
**A MONOTONE COMPLEMENTARITY PROBLEM IN HILBERT SPACE**
Jen-Chih Yao Apr. 1990 7 p
(Contracts N00014-89-J-1659; DE-FG03-87ER-25028; NSF DMS-89-13089)
(AD-A220819; SU-SOL-90-7) Avail: NTIS HC A02/MF A01 CSCL 12/2

An existence theorem for a complementary problem involving a weakly coercive monotone mapping over an arbitrary closed convex cone in a real Hilbert space is established. GRA

**N90-24106#** Technische Univ., Delft (Netherlands). Faculty of Technical Mathematics and Informatics.
**ANALOGUES OF THE LEBESGUE DENSITY THEOREM FOR FRACTAL SETS OF REALS AND INTEGERS**
Tim Bedford and Albert M. Fisher 1989 40 p Prepared in cooperation with Goettingen Univ., Fed. Republic of Germany
(Rept-89-88; ISSN-0922-5641; ETN-90-96687) Copyright Avail: NTIS HC A03/MF A01

A notion of density for fractal and fractal-like sets including certain kinds of Cantor sets and sparse sets of integers is introduced. Analogs of the Lebesgue density theorems for two types of fractal subsets of real numbers to Cookie-cutter Cantor sets and the zero set of Brownian path are proved. Analogs of Hausdorff dimension and Lebesgue density for subsets of integers are defined and a typical zero set of the simple random walk is proved to have dimension 1/2 and density square root of (2/pi). ESA

**N90-24107#** Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Analysis, Algebra and Geometry.
**AFFINE POLAR SPACES**
Arjeh M. Cohen and Ernest E. Shult (Kansas State Univ., Manhattan.) Jul. 1989 22 p Sponsored in part by NSF
(CWI-AM-R8909; ETN-90-96743) Copyright Avail: NTIS HC A03/MF A01

Affine polar spaces are polar spaces from which a hyperplane (that is a proper subspace meeting every line of the space) is removed. These spaces constitute natural examples of locally polar spaces. A characterization of affine polar spaces (rank at least 4) is given as locally polar spaces whose planes are affine. The affine polar spaces are classified in the sense that all hyperplanes of the classified polar spaces (rank at least 3) are determined. ESA

**N90-24108#** Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Operations Research, Statistics, and System Theory.
**ON THE STRUCTURE AT INFINITY OF A STRUCTURED SYSTEM**
J. W. vanderWoude Oct. 1989 19 p
(CWI-BS-R8918; ETN-90-96792) Copyright Avail: NTIS HC A03/MF A01

A graph theoretic characterization of the generic structure at infinity of the transfer matrix of a structured system is developed. The generic structure at infinity is shown to be determined by means of algorithms from combinatorial optimization based on the max-flow min-cut theorem, and on results concerning minimal cost flows. As an application of the obtained characterization, a structural version of two well-known disturbance decoupling problems is proposed. Graph theoretic necessary and sufficient conditions for the solvability of each of the two problems are derived. ESA

**N90-24109#** Technische Univ., Eindhoven (Netherlands).
**GEVREY SPACES RELATED TO LIE ALGEBRAS OF OPERATORS Ph.D. Thesis**
Antonius Frederik Ma TerElst 1989 129 p
(ETN-90-96892) Avail: NTIS HC A07/MF A01

The definition of a Gevrey space with given parameters of the open subset is presented. The Heisenberg group is mentioned as a special case. The space of Gevrey vectors is related to the Gelfand-Shilov space. A non-irreducible representation of a real unimodular group is considered. A reduction is proved for general semisimple Lie groups; they depend on the Casimir element in the complex universal enveloping algebra of the semisimple Lie algebra. ESA

# 70 PHYSICS (GENERAL)

For precision time and time interval (PTTI) see *35 Instrumentation and Photography;* for geophysics, astrophysics or solar physics see *46 Geophysics, 90 Astrophysics,* or *92 Solar Physics.*

**N90-24110#** Virginia Polytechnic Inst. and State Univ., Blacksburg.
**US ARMY RESEARCH OFFICE WORKSHOP ON SMART MATERIALS, STRUCTURES AND MATHEMATICAL ISSUES PROCEEDINGS Final Report, 8 Aug. 1988 - 7 Aug. 1989**
Craig A. Rogers, ed. and Iqbal Ahmad (ARO, Inc., Arnold Air Force Station, TN.) 1989 230 p Workshop held in Blacksburg, VA, 15-16 Sep. 1988
(Contract DAAL03-88-G-0043)
(AD-A218528; ARO-26372.1-MS-CF) Avail: NTIS HC A11/MF A02 CSCL 11/7

This workshop was held to identify recent significant developments and breakthroughs in science and technology. Its main objective is to evolve a consensus on the definition and characteristics of a smart/intelligent material or structure, and discuss mechanisms and possible methods to produce them. Another objective is to identify directions of future research in this field. Included are the abstracts/papers presented at the three sessions. The three sessions contain a wide range of presentations concerning numerous technologies for actuators, sensors, intelligence, control, constitutive modeling, and other scientific fields that have become essential to the emerging science and technologies of smart materials and structures. At the end of each session a discussion period was held to address some of the issues of general concern related to the mission of the workshop. GRA

**N90-24111#** Arizona Univ., Tucson. Optical Sciences Center.
**FELLOWSHIP IN PHYSICS/MODERN OPTICS AND QUANTUM ELECTRONICS Final Report, 1 Jul. 1986 - 31 Dec. 1989**
J. D. Gaskill 13 Feb. 1990 12 p
(Contract DAAL03-86-G-0024)
(AD-A218772; ARO-23757.16-PH-F) Avail: NTIS HC A03/MF A01 CSCL 20/10

Results are reported. Included are details of the progress made in the following areas: femtosecond laser system; CuCl thin-film etalons; commercial semiconductor-doped glasses; coherent effects in semiconductors; MBE-grown ZnSe; optical Stark effect; quantum dots; and generation of tunable femtosecond pulses. GRA

**N90-24112#** General Electric Co., Schenectady, NY. Corporate Research and Development.
**ADVANCED ARTIFICIAL DIELECTRIC MATERIALS FOR MILLIMETER WAVELENGTH APPLICATIONS, PART A Final Technical Report, 1 Aug. 1983 - 30 Jun. 1987**
Israel S. Jacobs 30 Nov. 1989 137 p
(Contract N00014-83-C-0447; NR Proj. RR0-2202)
(AD-A220221; GE-90-SRD-001-Pt-A) Avail: NTIS HC A07/MF A01 CSCL 20/3

This is Part A of a two-part Final Technical Report and is restricted to essentially non-magnetic composite dielectrics. Part B, which contains classified material, treats magneto-dielectric composites. We study the electromagnetic properties (permeability and permittivity) of artificial dielectrics with metal particles (1 micrometer to 37 micrometers) randomly loaded into both polymeric and inorganic binders. The alloy powder particles are oxide-coated for isolation (non-percolating) and ferromagnetic only below room temperature for volume loading determination, p. Samples with p from 0.1 to 0.4 for various size fractions, were examined from about 1 GHz to 20 GHz, and for selected samples at 35 GHz and 90 GHz. The complex permeability results are in very good agreement with calculations of induced magnetic dipole effects as functions of frequency and particle diameter. Permittivity results (real parts) are independent of particle diameter and essentially constant with frequency. Their dependence on loading is compared to the Clausius-Mossotti dipolar calculation, to the lattice array models with higher-order multipole interactions pioneered by Rayleigh, as well as to a pair-interaction model developed in this study; and also to an empirical curve obtained from several remarkably ideal experiments. The latter two comparisons are rather successful when the particles are closely spherical. GRA

# 71 ACOUSTICS

Includes sound generation, transmission and attenuation. For noise pollution see *45 Environmental Pollution.*

**N90-24113#** Naval Ocean Systems Center, San Diego, CA.
**APPLICATION OF FREQUENCY INTERPOLATION TO ACOUSTIC-STRUCTURE INTERACTION PROBLEMS Final Report**
G. W. Benthien Nov. 1989 23 p
(AD-A219330; NOSC/TR-1323) Avail: NTIS HC A03/MF A01 CSCL 20/1

For coupled structural acoustic scattering problems, the spectral response often varies rapidly over a large dynamic range, requiring the response to be calculated at many closely spaced frequencies. In such problems, the computation time is often dominated by the calculation of acoustic interactions which do not vary rapidly with frequency. It is shown that large savings in computation time can be achieved without significant loss of accuracy by interpolating on appropriately scaled intermediate acoustic quantities. These quantities are computed on a coarse frequency grid and then interpolated to any desired frequency resolution in order to obtain the final response. The overall savings in computation time is typically more than an order of magnitude. GRA

**N90-24114#** Naval Underwater Systems Center, New London, CT.
**ESTIMATION OF NOISE FIELD DIRECTIONALITY: COMPARISON WITH FOURIER SERIES METHOD**
Albert H. Nuttall 15 Oct. 1989 72 p Sponsored by ONR, Arlington, VA
(AD-A220366; AD-E501205; NUSC-TR-8599) Avail: NTIS HC A04/MF A01 CSCL 20/1

For a line array immersed in a stationary homogeneous noise field, the noise field directionality, at any temporal-frequency of interest, is estimated without any a priori assumptions about the field and without the limitations of ill-conditioning. The key to this development is the deferment of the inherent discretization associated with any array until after the integral equation for the noise field directionality has been solved in terms of the observed spatial correlation. Comparison with the Fourier series method reveals nearly identical results, except that the Fourier series method has some inaccurate low-order Fourier coefficients. Also, no Bessel function evaluations are required for the new method proposed here; instead, one FFT suffices for approximate evaluation of the field directionality. However, neither procedure has the superresolution capability of some of the recent eigen-decomposition approaches. GRA

**N90-24115#** Naval Underwater Systems Center, New London, CT.
**DIFFRACTION ABOUT ACOUSTICALLY SOFT PANELS**
Ronald P. Radlinski 8 Mar. 1990 19 p Presented at the 118th Meeting of the Acoustical Society of America, St. Louis, MO, Nov. 1989
(AD-A220850; NUSC/TD-8681) Avail: NTIS HC A03/MF A01 CSCL 20/1

The use of two-dimensional shaded and unshaded arrays to discriminate against diffraction about acoustically soft panels is investigated numerically by the use of a two-dimensional boundary element integral method. Calculated predictions for infinitely long strips are used to estimate the diffracted field at a hydrophone array behind a square baffle. The diffraction floor of the hydrophone array is determined by weighting the array elements with various shading coefficients. Comparisons of diffraction discrimination by a hydrophone array versus a single hydrophone at various positions are presented. GRA

**N90-24116#** Aeronautical Research Inst. of Sweden, Stockholm.
**ANALYSIS OF THE ENVIRONMENTAL NOISE SITUATION AROUND A LARGE SWEDISH PROTOTYPE WIND TURBINE**
Sten Ljunggren Dec. 1988 132 p Sponsored by Swedish National Energy Administration
(FFA-TN-1988-16; ETN-90-96597) Avail: NTIS HC A07/MF A01

Results from measurements of noise generated by the 2 MW prototype at Nasudden, Sweden, are presented together with corresponding data for natural wind-included sound. The results are discussed in the light of the possible masking of turbine noise by wind-induced background sound. As the frequency spectrum of the aerodynamic noise from a wind turbine is very similar to that of the wind sound, it is thought that the temporal fluctuations of the turbine noise as well as those of the background sound must be an important factor for masking. The results show that the fluctuations of the turbine noise at short distances downstream the turbine are dominated by a deterministic modulation at the blade passage frequency. This modulation is fairly small however, the peak values of the amplitude is in general less than 1 dB at a distance of 114 m. Random fluctuations become more important with increasing distance, but there are still traces of the deterministic modulation at a distance of 456 m in the downwind direction. Some analyses of the temporal fluctuations of wind-induced background are presented. ESA

# 72 ATOMIC AND MOLECULAR PHYSICS

Includes atomic structure, electron properties, and molecular spectra.

**N90-24117#** Louisiana State Univ., Baton Rouge. Dept. of Chemistry.
**THEORETICAL STUDIES OF ELECTRONS AND ELECTRON TRANSFER PROCESSES IN FLUIDS Final Progress Report, Feb. 1987 - Aug. 1989**
Neil R. Kestner 1989 25 p
(Contract DE-FG05-87ER-13674)
(DE90-008414; DOE/ER-13674/3) Avail: NTIS HC A03/MF A01

Research accomplished during this grant involved studies of: (1) interaction of hydrated metal ions which show that accurate model potentials demonstrate the distortion of hydration shells at high concentrations; (2) water-water interactions and weak intermolecular forces; (3) negative polar clusters and the pseudopotential for ammonia; (4) density functional theory (a very large calculation on the iron dimer was published; other work on the interaction of argon atoms was completed, and work on CO2, cobalt, and the ionization potential of various transition metal ions was completed); (5) sodium water clusters may be involved in photobleaching hydrated electrons, and collaborative work using path integral methods and Fast Fourier Transform methods are underway to obtain the excited states; (6) propane molecule interaction was used to evaluate its liquid properties; and (7) conducting polymers. DOE

**N90-24118** New South Wales Univ., Kensington (Australia). Dept. of Physics.
**PULSED AND MODULATED PASSAGE NMRON STUDIES OF COBALT-IRON ALLOYS Abstract Only Ph.D. Thesis**
Philip James Back Jun. 1988 4 p
Avail: Issuing Activity

This thesis describes an experimental investigation of hyperfine interactions at cobalt nuclei diffused into iron hosts, using Nuclear Magnetic Resonance on Oriented Nuclei (NMRON). A principal part of this study is an extension of the original Pulsed NMRON program, with the aim of identifying a possible nuclear spin-spin interaction, and characterizing the dependence of the rapid spin echo decay time on neighboring nuclear magnetic moments. Various measurements are included and discussed. Author

**N90-24119#** Rome Univ. (Italy). Dipt. di Fisica.
**TEMPERATURE EVOLUTION OF SINGLE PARTICLE CORRELATION FUNCTIONS OF TIP4P WATER**
R. Frattini, M. A. Ricci, G. Ruocco, and M. Sampoli (Florence Univ., Italy ) 7 Sep. 1989 48 p Submitted for publication
(Preprint-694; ETN-90-96517) Avail: NTIS HC A03/MF A01

A Molecular Dynamics (MD) simulation of TIP4P water at various temperatures is reported. The autocorrelation functions of linear and angular velocities and of the first and second rank rotation matrices are studied and compared with previous data obtained using different potential models. The comparison with the results of MD simulations of heavy water and hydrogen sulfide is also shown. ESA

**N90-24120*#** Sussex Univ., Brighton (England). Div. of Physics and Astronomy.
**BARYOGENESIS IN EXTENDED INFLATION. PART 1: BARYOGENESIS VIA PRODUCTION AND DECAY OF SUPERMASSIVE BOSONS**
John D. Barrow, Edmund J. Copeland, Edward W. Kolb (Fermi National Accelerator Lab., Batavia, IL.), and Andrew R. Liddle May 1990 20 p Prepared in cooperation with Illinois Univ., Chicago Sponsored in part by SERC and DOE
(Grant NAGw-1340)
(NASA-CR-180615; NAS 1.26:180615; SUSSEX-AST-90/5-1; FNAL-Pub-90/62-A) Avail: NTIS HC A03/MF A01 CSCL 20H

Baryogenesis occurring during the thermalization stage at the end of extended inflation is considered. In extended inflation, the Universe passes through a first-order phase transition via bubble nucleation; inflation comes to an end when bubbles collide and their collisions convert energy stored in the bubble walls into particles. This naturally provides conditions well out of thermal equilibrium in which baryon number violating processes may proceed; the amount of baryon asymmetry which may be produced this way is estimated. The avoidance of a monopole or domain wall problem can also be ensured and isothermal density perturbations may arise as a remnant of spatial variation in the baryon asymmetry. Author

**N90-24121*#** Fermi National Accelerator Lab., Batavia, IL.
**CHIRAL INTERFACE AT THE FINITE TEMPERATURE TRANSITION POINT OF QCD**
Z. Frei and A. Patkos (European Organization for Nuclear Research, Geneva, Switzerland ) May 1990 13 p Sponsored in part by DOE and NSF
(Grant NAGw-1340)
(NASA-CR-186605; NAS 1.26:186605; FERMILAB-Pub-90/114-A) Avail: NTIS HC A03/MF A01 CSCL 20H

The domain wall between coexisting chirally symmetric and broken symmetry regions is studied in a saddle point approximation to the effective three-flavor sigma model. In the chiral limit the surface tension varies in the range ((40 to -50)MeV)(exp 3). The width of the domain wall is estimated to be approximately or equal to 4.5 fm. Author

**N90-24122*#** Fermi National Accelerator Lab., Batavia, IL.
**PERIODIC SIGNATURES FOR THE DETECTION OF COSMIC AXIONS**
Michael S. Turner May 1990 10 p Prepared in cooperation with Chicago Univ., IL
(Grants NAGw-1340; FG02-90ER-40560)
(NASA-CR-186608; NAS 1.26:186608; FERMILAB-Pub-90/89-A) Avail: NTIS HC A02/MF A01 CSCL 20H

In a Sikivie-type cosmic-axion detector, both the width and position of the microwave signal due to axion-photon conversion depend upon the motions of the earth. Due to the orbital and rotational motions of the earth they will be modulated with periods of 1 sidereal day and 1 sidereal year, with amplitudes of about 0.1 percent and 5 percent respectively. Because of the intrinsically-high energy resolution of Sikivie-type detectors such periodic variations should be detectable. Such modulations would not only aid in confirming the detection of cosmic axions, but, if found, would also provide important information about the distribution of axions in the halo. Author

**N90-24123*#** Chicago Univ., IL. Dept. of Physics.
**COSMOLOGICAL BARYON AND LEPTON NUMBER IN THE PRESENCE OF ELECTROWEAK FERMION-NUMBER VIOLATION**
Jeffrey A. Harvey and Michael S. Turner Mar. 1990 12 p Prepared in cooperation with Fermi National Accelerator Lab., Batavia, IL Sponsored in part by the Alfred P. Sloan Foundation
(Grants NAGw-1340; NSF PHY-86-58033)
(NASA-CR-186609; NAS 1.26:186609; FERMILAB-Pub-90/49-A; EFI-90-33) Avail: NTIS HC A03/MF A01 CSCL 20H

In the presence of rapid fermion-number violation due to nonperturbative electroweak effects certain relations between the baryon number of the Universe and the lepton numbers of the Universe are predicted. In some cases the electron-neutrino asymmetry is exactly specified in terms of the baryon asymmetry. Without introducing new particles, beyond the usual quarks and leptons, it is necessary that the Universe possess a nonzero value of B - L prior to the epoch of fermion-number violation if baryon and lepton asymmetries are to survive. Contrary to intuition, even though electroweak processes violate B + L, a nonzero value of B + L persists after the epoch of rapid fermion-number violation. If the standard model is extended to include lepton-number violation, for example through Majorana neutrino masses, then electroweak processes will reduce the baryon number to zero even in the presence of an initial B - L unless 20 M(sub L)

approximately greater than the square root of (T(sub B - L) m(sub P1)) where M(sub L) sets the scale of lepton number violation and T(sub B - L) is the temperature at which a B - L asymmetry is produced. In many models this implies that neutrinos must be so light that they cannot contribute appreciably to the mass density of the Universe. Author

**N90-24124#** Maryland Univ., College Park. Dept. of Physics and Astronomy.
**CHOPPER FOR NEUTRINOS AND ANTINEUTRINOS Final Report, 1 Sep. 1987 - 31 Dec. 1988**
J. Weber 31 Oct. 1989 23 p
(Contract F49620-87-C-0112)
(AD-A218402; AFOSR-90-0080TR) Avail: NTIS HC A03/MF A01 CSCL 20/8

A new approach to weak interaction physics employs detectors which are nearly perfect single crystals, with high Debye temperatures. Total scattering cross sections are proportional to the square of the total number of quarks. Available sources of antineutrinos exert macroscopic forces on such crystals as a result of elastic scattering. In this paper a chopper is described for modulating the antineutrino forces, in order to excite normal modes of elastic solids. Experiments are reported. GRA

**N90-24125#** Naval Postgraduate School, Monterey, CA. Dept. of Physics.
**DOSE ANALYSIS OF THE MODEL 112A PULSERAD PULSED X RAY GENERATOR BY ITS CYLTRAN M.S. Thesis**
Jong Ryul Kim Dec. 1989 81 p
(AD-A220372) Avail: NTIS HC A05/MF A01 CSCL 20/15

The radiation output from the NPS Pulserad 112A x ray Generator has been calculated using the ITS code CYLTRAN. The results of this numerical simulation have been compared to the experimental measurements taken previously. These calculations show that the overall photon energy spectrum is independent of the electron source beam parameters such as beam radius and angular distribution. A previously unexplained measured dip in the radiation dose at beam center line can be explained with an angular divergence of the electron beam from the cathode. The simulation is successful in explaining the pattern of the dose distribution, but the calculation is in general much smaller than the measured values. This inability to reproduce the magnitude of the dose pattern points out the need to measure the radiation dose each time the Pulserad 112A is used. Some suggestions for explaining this discrepancy are included. GRA

**N90-24126#** Stockholm Univ. (Sweden). Inst. of Physics.
**HYPERON PRODUCTION AT 200 AND 900 GeV cm ENERGY**
R. E. Ansorge, B. Asman, L. Burow, P. Carlson, R. S. DeWolf, B. Eckart, G. Ekspong, C. Fluglesang, J. Gaudaen, and C. Geich-Gimbel (Bonn Univ., Germany, F.R. ) et al 1989 14 p Sponsored by Belgium National Foundation for Fundamental Research; BMFT; United Kingdom Science and Engineering Research Council; and Swedish Natural Science Research Council Prepared in cooperation with CERN, Geneva, Switzerland
(USIP-89-02; ETN-90-96595) Avail: NTIS HC A03/MF A01

THe production of lambda and xi particles in proton-antiproton collisions was studied using decays observed in the UA5 streamer chambers. Results are compared to previous 546 GeV data, to results from other experiments and to four theoretical models. The lambda particle yield per inelastic event is estimated. A mean number of xi particles per inelastic collision is given. Estimations of the average transverse momentum of lambda and xi particles in the rapidity region are given. Ratio of lambda to xi particle production is consistent to that found in e+e- collisions and lower energy pp collisions but lower than the value obtained at 546 GeV. Average particle composition is estimated. ESA

**N90-24127#** Technische Univ., Eindhoven (Netherlands).
**POLARIZATION EFFECTS IN IONIZING COLLISIONS WITH Ne*(3-P2)- AND Ne**(3-D3)-ATOMS Ph.D. Thesis**
Johannes Petrus Jose Driessen 19 Dec. 1989 193 p Sponsored by Foundation for Fundamental Research on Matter
(ETN-90-96891) Avail: NTIS HC A09/MF A01

Aspects of Penning ionization study are addressed. The essence of the collision dynamics is described, with the emphasis on locking phenomena. The crossed-beam experiment is described. Polarized-atom cross sections as a function of the collision energy in a broad energy range were determined experimentally. A semiclassical model in which the locking phenomenon was incorporated by a simple criterion was theoretically developed. Ab-initio autoionization widths for the N*(*)-Ar system were calculated. The proven success of the combination of these three aspects indicates that the semiclassical description of the collision dynamics can serve as a solid basis for total cross section calculations. ESA

# 73 NUCLEAR AND HIGH-ENERGY PHYSICS

Includes elementary and nuclear particles; and reactor theory.

For space radiation see *93 Space Radiation.*

**N90-24128#** Naval Research Lab., Washington, DC. Airborne Radar Branch.
**DEVELOPMENT OF A HYBRID ADAPTIVE BEAMFORMER Formal Report, Jun. 1986 - May 1988**
F. W. Lee 28 Feb. 1990 23 p Sponsored by NADC, Warminster, PA
(AD-A219652; NRL-9249) Avail: NTIS HC A02/MF A01 CSCL 17/9

Elements of adaptive array systems are reviewed and compared with the Adaptive Processing Laboratory equipment. Candidate locations for the beamforming network are investigated and development of an Intermediate Frequency Adaptive Beamformer is presented. Due to the hybrid analog/digital nature of the IF Beamformer, numerical techniques are developed for both characterization and control of the device. Performance data for the beamformer are presented. The purpose of this investigation was to develop and demonstrate the capabilities of a fully adaptive linear array beamformer. Radar systems routinely use sensor arrays for signal detection and estimation. The use of sensor arrays, instead of single sensor systems, provides radar systems the advantages of improved antenna directive gain and the ability to exploit the geometrical properties of their spatial beam patterns. One such sensor array system is an adaptive array. Adaptive array systems sense the signal environment and then automatically adjust their spatial beam patterns to improve a specified performance index, usually the signal-to-interference noise ratio (SINR). These systems, therefore, perform optimally in adverse signal environments without prior knowledge of that environment. Adaptive arrays also overcome sensor failure more gracefully than conventional arrays. GRA

# 74 OPTICS

Includes light phenomena; and optical devices.

For lasers see *36 Lasers and Masers.*

**N90-24129#** Arizona Univ., Tucson. Optical Sciences Center.
**MULTIPLE BEAM OPTICAL PROCESSING Final Technical Report, 29 Jan. 1987 - 29 Jan. 1989**
Hyatt M. Gibbs, N. Peyghambarian, G. Khitrova, S. Koch, R. Kostuk, A. Macleod, K. Wagner, D. Roude, and M. Warren Dec. 1989 241 p
(Contract F30602-87-C-0009; ARPA Order 5796; AF Proj. E796)
(AD-A219048; RADC-TR-89-280) Avail: NTIS HC A11/MF A02 CSCL 20/6

The objective of this effort was to develop optical processing technology required to implement high performance signal processing systems. The work concentrated on the evaluation and

characterization of GaAs nonlinear etalons and methods of using these etalons in optical processing functions. Experiments included the implementation of a one bit adder using symbolic substitution, a pattern recognizer that can distinguish between simple three spot patterns, an associative memory which can discriminate against two different input objects, and an all optical compare and exchange module which can compare the magnitude of two digital input signals and make an appropriate exchange decision. These experiments, although rudimentary, may be extendable to larger scales upon further development of the optical processing technology. GRA

**N90-24130#** Minnesota Mining and Mfg. Co., Saint Paul. Fiber Optics Lab.
**OPTICAL FIBER FOR ACOUSTIC SENSOR APPLICATIONS Bimonthly Activity Report No. 1, Oct. 1989 - Jan. 1990**
James R. Onstott Feb. 1990 14 p
(Contract N00014-89-C-2455)
(AD-A219323) Avail: NTIS HC A03/MF A01 CSCL 20/6

Design of two single mode optical fibers for use in acoustic sensing systems is reported. One fiber design is optimized for use in optical coupler fabrication while the second design is optimized for use as an acoustic sensing fiber. The second fiber will be used as the basis for development of optimized coating for optical fiber acoustic sensor applications. GRA

**N90-24131#** Alabama Univ., Huntsville. Center for Applied Optics.
**OPTICAL COMPUTING STRATEGIES Final Report**
H. J. Caulfield Feb. 1990 253 p
(Contract N00014-86-K-0591)
(AD-A219433) Avail: NTIS HC A12/MF A02 CSCL 09/5

A very diverse effort to explore and develop the role of optical computing for SDI purposes is covered. The effort was in two fields: optical algebra and massive parallel holographic interconnection. There was work on a variety of other activities such as pattern recognition, optical interconnection, and low energy optical computing. Optics was suggested for algebra for many years, because there are geometry in configurations which permit it to be done extremely rapidly. The major problem with optical algebra was that high accuracy was essentially unobtainable. This was to show that one could use low accuracy optics for the computationally intense part of algebraic computations and bootstrap the accuracy with moderately high accuracy digital electronics in very simple, hard-wired configurations. GRA

**N90-24132#** Texas A&M Univ., College Station. Dept. of Electrical Engineering.
**ADVANCED GUIDED WAVE ELECTRO-OPTICAL SWITCHES Final Technical Report, Apr. 1987 - Apr. 1989**
O. Eknoyan and H. F. Taylor Feb. 1990 48 p
(Contract F19628-87-K-0027)
(AD-A219784; RADC-TR-89-357) Avail: NTIS HC A03/MF A01 CSCL 20/6

Efforts have concentrated on the use of LiTaO3 which is emerging as a superior alternative to the more commonly used LiNbO3 because of its higher immunity to optical damage. The progress made has resulted in the establishment of vapor diffusion technique for making low loss optical waveguides and its extension for making low loss waveguides by thermal diffusion below Curie temperature that support both TE and TM modes; the development of polarization independent guided-wave electrooptic switches; and the realization of lowest propagation loss ridge waveguides using the RIE process. Progress has also been made on the use of SBN:60. Specifically, a method for producing rib structures was devised and high index optical waveguides were obtained. GRA

**N90-24133#** Spectra Technology, Inc., Bellevue, WA.
**KINETIC AND EXTRACTION MEASUREMENTS ON 12C18O2 Final Report, 6 Sep. 1988 - 5 Aug. 1989**
C. H. Fisher, C. E. Hamilton, R. D. Mead, and A. L. Pindroh 31 Oct. 1989 91 p
(Contract F19628-88-C-0141; AF Proj. 7670)
(AD-A220417; GL-TR-89-0292) Avail: NTIS HC A05/MF A01 CSCL 09/3

A candidate transmitter source for a space borne pulsed Doppler wind-sensing lidar is the Carbon dioxide laser. To minimize beam propagation losses due to atmospheric CO2 extinction, a rare isotope is used as the active laser molecule. The particular rare isotope and laser transition is further determined by choosing a transition wavelength that minimizes the propagation losses and maximizes the backscatter coefficient of the atmospheric aerosol background. The 12C18O2 isotope R(20) transition at 9.11 micrometer coincides with a Sellmier resonance of predominant aerosol constituents and papers to be the optimum choice. The performance of a 12C18O2 laser capable of fulfilling the global wind-sensing mission was addressed analytically and experimentally in this study. Gain and collisional deactivation rate measurements were conducted in an x ray preionized, self-sustained discharge laser testbed, by observing the effect of propagation through the laser medium on a cw 12C18O2 laser probe beam. The kinetic rates derived from the measurements deviated significantly from similar published measurements for the abundant 12C16O2 isotope. The new rate information was input into an existing kinetics code, and laser parameters required for a 10 J/pulse and 3 microsecond duration pulse were deduced. GRA

**N90-24134#** Rome Air Development Center, Griffiss AFB, NY.
**OPTICAL LINKS FOR MICROWAVE APPLICATION**
Edward N. Toughlian, Steven T. Johns, and Mark C. Schmitt Mar. 1990 31 p
(AF Proj. 4600)
(AD-A220574; RADC-TR-90-12) Avail: NTIS HC A03/MF A01 CSCL 20/6

The RADC Directorate of Communications, Communications ECCM Section, in cooperation with the RADC Photonics Laboratory, Lightwave Signal Processing Group, is in the process of replacing the existing RF cabling system of their anechoic chamber with optical links. Fiber optic links will be employed in an effort to upgrade the DCCD anechoic chamber test facility. It is expected that any electro-magnetic interference emanating from the existing microwave system can be reduced measurably by replacing the antenna coaxial cabling and its associated components with optical link systems. This effort should not only improve the DCCD test bed, but will yield valuable data about the future of optical component applications in the microwave domain. This report details the Photonics Laboratory's portion of this effort. While this report is related to this specific application, a more detailed characterization and analysis of the optical links will be carried out to provide information as to feasibility of using optical links as fiber feeds in microwave systems. We report on the performance of these fiber optic components in the area of their noise contribution, bandwidth, and dynamic range capabilities as related to the needs of a typical communications system. GRA

**N90-24135#** Carnegie-Mellon Univ., Pittsburgh, PA. Center for Excellence in Optical Data Processing.
**OPTICAL NEURAL NETS FOR SCENE ANALYSIS Final Report, Apr. 1989 - Mar. 1990**
David Casasent Mar. 1990 126 p
(Contract DAAH01-89-C-0418; ARPA Order 6671)
(AD-A220657) Avail: NTIS HC A07/MF A01 CSCL 12/9

Our objective is to develop new neural net algorithms and architectures for scene analysis and to demonstrate them on a fabricated new hardware laboratory neural net. Our approach marries pattern recognition and neural net techniques and optical/digital technologies. Our hardware laboratory system uses digital and optical neural net hardware in an analog neural net. Our algorithms are intended to be useful on such low accuracy analog hardware. Our algorithms cover a wide range of neural net algorithms and architectures. These can all be utilized on the same laboratory hardware. Our algorithms include five new optimization neural nets (matrix-inversion, mixture multitarget

racking, symbolic, and production system neural nets) and an adaptive neural net (adaptive clustering neural net). GRA

**N90-24136#** Syracuse Univ., NY. Dept. of Electrical and Computer Engineering.
**REMOTE OPTICAL SENSING Final Technical Report, Jun. 1988 - Sep. 1989**
Philipp Kornreich Mar. 1990 42 p
(Contract F30602-88-D-0027; AF Proj. 4600)
(AD-A220780; RADC-TR-89-388) Avail: NTIS HC A03/MF A01 CSCL 20/6

One of the major advantages of optical systems is their ability to process a great deal of information in parallel. The optical system discussed here transmits a complete image through a single optical fiber. This transmission system preserves the three-dimensional and color information of the image. The resolution is limited by the number of modes that can propagate in the fiber. The image is inserted and retrieved from the fiber by tapered input and output sections connected to the ends of the fiber. We built and tested a prototype image transmission system. We successfully transmitted a standard AF target through the system. We present an analysis of how an image propagates through such a system. The model is derived from the electro-magnetic field equations. The image transmitted through the fiber does not necessarily have to be a picture of a real physical object. It could consist of various bits of information transmitted through the fiber in parallel. The transverse electric as well as the magnetic field modes propagate in the structure at different speeds. However, at periodic intervals all modes are in phase. GRA

**N90-24137#** Environmental Research Inst. of Michigan, Ann Arbor.
**AN ASSESSMENT OF THE CD-FLIR AS AN ARGUS SENSOR Final Report**
D. J. White Mar. 1990 63 p
(AD-A220841; Rept-223500-1-F) Avail: NTIS HC A04/MF A01 CSCL 17/5

The CD-FLIR is a U.S. Government-owned thermal imaging system that has been made available for use on the ARGUS aircraft. This report presents the results of a study in which the expected performance of this sensor is defined. Recommendations are made for several simple hardware modifications that will permit optimum sensor performance. Also, the performance impact of using analog vs. digital recording is considered. GRA

**N90-24138#** Societe Bertin et Cie, Les Milles (France).
**TELESCOPE CONSIDERED AS A VERY HIGH GAIN ANTENNA**
Michel Detaille and Patrice Houmault 1990 10 p Presented at OE/LASE 1990 Symposium on Optics, Electro-Optics, and Laser Applications in Science and Engineering, Los Angeles, CA, 14-19 Jan. 1990
(Contract SE-64101S)
(ETN-90-96614) Avail: NTIS HC A02/MF A01

In the SILEX program, the telescope, and a focal system composed of a Cassegrain telescope and a dioptric collimator, are studied. The general concept and the results obtained on the telescope breadboard, which is very similar to the flight model, are presented. Local angular distortion influence and transmission antenna gain are explained. ESA

**N90-24139#** Aerospatiale, Cannes (France).
**WEARING OF CRYOMECHANISMS AT 4 K**
Gerard Luciano Jun. 1989 6 p
(Rept-892-440-103; CA-6/89; ETN-90-96660) Avail: NTIS HC A02/MF A01

Certain spaceborne optics include components that are designed to improve the instrument's performance. Where such mechanisms cannot be decoupled from the optical devices, pollution from the wear of those mechanisms must be minimized due to impossibility of inflight, or even sometimes on-ground cleaning of optical devices. Aerospatiale who are responsible for the optical bench of the infrared camera to be flown on board the ISO spacecraft, were therefore led to develop non-polluting mechanisms. Comparative tests were performed on several couples of materials, resulting in choice of a satisfactory solution. ESA

**N90-24140#** Oak Ridge National Lab., TN. Applied Technology Div.
**MATERIAL EVALUATION OF OPTICAL FIBERS AND PAYOUT BOBBINS: AN OVERVIEW**
D. J. Adams, M. R. Cates, C. J. Janke, J. D. Muhs, and J. T. Shaffer Mar. 1990 65 p
(Contract DE-AC05-84OR-21400)
(AD-A220104; ORNL/ATD-26) Avail: NTIS HC A04/MF A01 CSCL 20/6

This project was undertaken by the Applied Technology Division of the Oak Ridge National Laboratory (ORNL) to provide a cursory assessment of the U.S. Army Missile Commands's (MICOM's) Fiber Optic Guided Missile program. MICOM provided funding to ORNL in the amount of $35,000 over the four-month performance period of September through December 1989. The funding was applied to provide staff who could relate its experiences lessons learned to MICOM's program. This report documents the findings and recommendations of that ORNL team. GRA

**N90-24141#** University Coll. of North Wales, Bangor. School of Electronic Engineering Science.
**FAST ACTING OPTICAL BEAM DEFLECTION SYSTEM Final Report, 27 Apr. 1988 - 26 Apr. 1989**
D. K. Das-Gupta 8 Feb. 1990 29 p
(Contract DAJA45-88-C-0019; DA Proj. 1L1-61103-BH-57)
(AD-A220186; R/D-5821-MS-01-F) Avail: NTIS HC A03/MF A01 CSCL 20/6

This report describes the results of a study of the nature of optical deflection in the wave length range of 300 to 1000 nm, using transmission gratings of two different surface relief profiles, i.e., blazed saw-toothed and phase sinusoidal types. The experimental results confirm the theoretical predictions and provide a quantitative comparison of the performances of the two profiles. An analysis of results leads to the recommendation of the sinusoidal profile in preference to the blazed (saw-toothed) gratings. A broad-band high attenuation across the optical to near infrared frequencies may be achieved by the use of cross grating structure with sinusoidal profile of judicious groove depth. Of the four usable sinusoidal gratings provided by the Cambridge Consultants Ltd., the quality of the two photoresist grating materials was found to be superior to that of synthetic fused silica (hard etched). GRA

**N90-24142#** Michigan Univ., Ann Arbor. Dept. of Electrical Engineering and Computer Science.
**INVESTIGATIONS OF LATERALLY COUPLED ALL OPTICAL SWITCHES AND DETECTORS ON SILICA FIBERS Final Report, 15 May 1986 - 31 Dec. 1989**
Pallab K. Bhattacharya 22 Feb. 1990 9 p
(Contract DAAL03-86-K-0105)
(AD-A220297; ARO-23685.16-EL) Avail: NTIS HC A02/MF A01 CSCL 20/6

It is of interest to explore the possibility of fabricating active and passive device element such as switches, guides, couplers and detectors on or around single mode optical fibers. Such on-line detection and signal processing would be extremely useful for long-range fiber-optic communication. With this in mind, we have explored heterostructure and quantum well devices which can be laterally coupled to fibers, investigated the growth of GaAs and related materials on silica, fibers and sapphire by molecular beam epitaxy, and have demonstrated for the time the fabrication and performance of active optoelectronic devices on silica fibers. The lateral coupling of light of fibers into photodiodes has been characterized experimentally. Two novel heterostructure devices have been demonstrated. The first is a bipolar phototransistor with a staircase superlattice in the collector in which selective gain is achieved. The other is a photonic switching device made as a vertic directional coupler with a nonlinear MQW coupling medium. GRA

**N90-24143#** Max-Planck-Inst. fuer Stroemungsforschung, Goettingen (Germany, F.R.).
**EVALUATION AND REPRESENTATION OF TWO AND THREE DIMENSIONAL DATA FIELDS FROM OPTICAL STREAM MEASUREMENTS Thesis [ZUR AUSWERTUNG UND DARSTELLUNG ZWEI- UND DREIDIMENSIONALER DATENFELDER AUS OPTISCHEN STROEMUNGSMESSUNGEN]**
Peter Helmut Baumann Oct. 1989 76 p In GERMAN
(MPIS-18/1989; ISSN-0436-1199; ETN-90-96473) Avail: NTIS HC A05/MF A01

The half automatic evaluation of interferograms is developed. A process for interpolation of interference order function between the edges of interference bands is achieved, which evaluates the intensity in the interferogram to improve the accuracy. Two different processes of quasi three dimensional representation of two dimensional scalar fields are implemented by means of color and a radiation model. For three dimensional scalar fields, a process is developed to obtain the tomographic data of stream fields. To allow an incresing of the image frequency by the representation of three dimensional scalar fields, more speed hardware is necessary, which is possible by a velocity optimization of the algorithm. ESA

**N90-24144#** Ecole Centrale de Lyon (France). Lab. de Physicochimie des Interfaces.
**CHARACTERIZATION BY MEANS OF ELECTROCHEMICAL IMPEDANCE MEASUREMENT AND OPTOELECTROCHEMICAL ANALYSIS OF ELECTROLYTIC, INSULATING, AND SEMICONDUCTING SOLUTION STRUCTURES. DEVELOPMENT OF A CARTOGRAPHIC ANALYSIS METHOD FOR OPTOELECTROCHEMICAL IMPEDANCE Ph.D. Thesis [CARACTERISATION PAR LA MESURE DES IMPEDANCES ELECTROCHIMIQUES ET OPTOELECTROCHIMIQUES DE STRUCTURE SOLUTION ELECTROLYTIQUE/ISOLANT/SEMICONDUCTOR (EIS) MISE AU POINT D'UNE METHODE D'ANALYSE CARTOGRAPHIQUE DES IMPEDANCES OPTOELECTROCHIMIQUES]**
Pascal Royer 1989 159 p In FRENCH
(ECL-89-15; ETN-90-96944) Avail: NTIS HC A08/MF A01

Characterization methods for the analysis of the silicon oxide compounds involved in semiconductor-insulating compound interfaces are presented. The reasons for developing more precise characterization methods are described. An electrochemical impedance method is presented. Experimental and theoretical results using this technique are compared. Photoelectrochemical impedance measuring techniques are described. A theoretical analysis of structural behavior is proposed which explains similarities in the experimental results obtained using electrochemical and photoelectrochemical techniques. A cartographic approach to photoelectrochemical impedance analysis is described. ESA

# 75 PLASMA PHYSICS

Includes magnetohydrodynamics and plasma fusion.

For ionospheric plasmas see *46 Geophysics*. For space plasmas see *90 Astrophysics*.

**N90-24145#** Southwest Research Inst., San Antonio, TX.
**EVALUATION OF SPACE PLASMA DATA: EFFECTS UPON SPACECRAFT MATERIALS AND PREDICTIONS OF HAZARDOUS CONDITIONS; POLAR ARCS Final Report, 10 Aug. 1988 - 28 Feb. 1990**
L. A. Weiss, J. D. Winningham, and J. R. Sharber 28 Feb. 1990 34 p
(Contract DLA900-84-C-0910)
(AD-A219509; SWRI-17-7958-801-01) Avail: NTIS HC A03/MF A01 CSCL 04/1

The Polar ARCS campaign consisted of a highly coordinated set of ground based, airborne, and in situ measurements of a polar cap aurora over Sondrestrom, Greenland, on February 26, 1987. Three charges of barium were injected into the F-region ionosphere immediately prior to the launch of a Black Brant IX rocket instrumented with ac and dc magnetometers, plasma wave and electric field probes, and ion/neutral and electron spectrometers. Simultaneous electron density and line-of-sight measurements were made by the Sondrestrom incoherent scatter radar, and all-sky imaging photography was performed by the AFGL Airborne Ionospheric Observatory (AIO). The electron measurements and data analysis, interplanetary magnetic field (IMF) and DMSP satellite data are presented in an attempt to establish the global morphology of the polar cap during the campaign. The current status of the data from each of the other instruments is also assessed and recommendations for further data analysis are made. GRA

**N90-24146#** Naval Research Lab., Washington, DC. Radiation Hydrodynamics Branch.
**ADVANCED CONCEPTS THEORY ANNUAL REPORT, 1989 Final Report**
29 Mar. 1990 173 p
(Contract MIPR-89-565)
(AD-A220768; NRL-MR-6612) Avail: NTIS HC A08/MF A01 CSCL 20/9

This report details the work of the Radiation Hydrodynamics Branch conducted in FY 89 with respect to several critical problems concerning the design of z-pinch implosions and the optimization of their radiative output. Separate sections describe progress in the analysis of z-pinch experiments, the development of atomic, electron, plasma and MHD dynamical models to describe z-pinch implosions, and the analysis of atomic number scaling of z-pinch K-shell emission. GRA

**N90-24147#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**INVESTIGATION OF THE EFFECT OF MECHANICAL STRESS ON COLD FUSION M.S. Thesis**
Barton H. Wohl Mar. 1990 68 p
(AD-A220123; AFIT/GNE/ENP/90M-8) Avail: NTIS HC A04/MF A01 CSCL 18/1

The purpose of this research was to see if the phenomenon known as cold fusion could be observed after loading a sample of titanium with deuterium gas and then subjecting the sample to mechanical stress. Samples of commercially pure titanium were loaded with deuterium by heating them inductively to 643 + or - 4 C while they were in a deuterium atmosphere. After loading, the samples were subjected to either dynamic tensile stress, a static load, or shear stress. The samples were surrounded by a 4-pi neutron detector during the application of stress and data from the detection system was analyzed for either large bursts of neutrons or continuous low-level emission of neutrons. Despite the fact that the neutron detection system was sensitive to certain environmental factors, application of tensile stress caused no positive indications of cold fusion. One suspiciously large count did occur during the application of shear stress, but that part of the experiment was relatively uncontrolled, and it is believed that the one large count was caused by environmental factors. An upper limit of 1.2 x 10(exp -24) neutrons/deuteron pair/s was calculated for the samples involved in the research. This is based on the limits of sensitivity of the neutron detection system. GRA

# 76 SOLID-STATE PHYSICS

Includes superconductivity.

For related information, see also *33 Electronics and Electrical Engineering* and *36 Lasers and Masers*.

**N90-24148#** Oak Ridge National Lab., TN. Solid State Div.
**IN-SITU PROCESSING OF EPITAXIAL AND TEXTURED HIGH (Tc) SUPERCONDUCTING HoBa2Cu3O(7-x) THIN FILMS BY PULSED LASER EVAPORATION TECHNIQUE**
C. B. Lee, R. Prasad, A. K. Singh, S. Sharan, R. K. Singh, J. Narayan (North Carolina State Univ., Raleigh.), O. W. Holland,

and L. A. Boatner 1989 4 p Presented at the Materials Research Society Fall Meeting, Boston, MA, 27 Nov. - 2 Dec. 1989
(Contract DE-AC05-84OR-21400)
(DE90-009828; CONF-891119-121) Avail: NTIS HC A01/MF A01

Excellent quality epitaxial and textured superconducting HoBa2Cu3O(7-x)(Ho123) thin films have been fabricated on lattice matched (100) KTaO3 and (100) LaAlO3 and lattice mismatched (100) MgO substrates by the pulsed laser evaporation (PLE) technique. A bulk Ho 123 target was evaporated using nanosecond excimer laser pulses with the evaporating material depositing on a substrate maintained in the temperature range of 550 to 650 C. The temperature for zero resistance for HoBa2Cu3O(7-x) films deposited on various substrates at 650 C varied between 85 to 89K. The epitaxial films deposited on (100) LaAlO3 substrates exhibited critical current densities greater than 3.5 x 10(exp 6) Amps/sq cm at 77 K. The superconducting properties of the Ho 123 films were found to be similar to Y 123 films. DOE

**N90-24149#** Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics.
**ON THE EXPLANATION OF ANOMALIES IN INELASTIC NEUTRON SCATTERING BY HIGH-T(SUB c) SUPERCONDUCTORS**
N. M. Plakida, V. J. Aksenov, S.-L. Drechsler, T. Galbaater, R.-J. Rakauskas, and S. Stamenkovic (Institut za Nuklearne Nauke Boris Kidric, Belgrade, Yugoslavia ) 1988 12 p
(DE90-620561; JINR-E17-88-822) Avail: NTIS HC A03/MF A01

The nuclear inelastic neutron scattering on highly anharmonic vibrations of oxygen ions in high-T (sub c) superconductors is considered. In the framework of a pseudo-spin model associated with rotational vibrations of O-CU-O molecules both coherent and incoherent scattering cross-sections are evaluated. A possible explanation of experimentally observed anamalous temperature and angular dependences of inelastic neutron scattering intensity in high-T(sub c) superconductors LSCO and YBCO is proposed.
Author

**N90-24150*** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**METHOD AND APPARATUS FOR DETERMINING OPTICAL ABSORPTION AND EMISSION CHARACTERISTICS OF A CRYSTAL OR NON-CRYSTALLINE FIBER Patent**
Charles E. Byvik, inventor (to NASA) and A. Martin Buonchristiani, inventor (to NASA) (Buoncristiani, A. Martin, Newport News, VA ) 2 Jan. 1990 8 p Filed 16 Aug. 1988 Supersedes N89-14119 (27 - 5, p 703)
(NASA-Case-LAR-13963-1; US-Patent-4,890,915;
US-Patent-Appl-SN-232735; US-Patent-Class-356-73;
US-Patent-Class-356-73.1; Int-Patent-Class-G01N-21/64;
Int-Patent-Class-G01N-21/84) Avail: US Patent and Trademark Office CSCL 20L

This invention relates generally to spectroscopy and, more particularly, to a method and apparatus for performing spectroscopic analysis of crystal and noncrystalline fibers. The invention provides a complete absorption curve for a material using a crystal fiber which can be more easily produced than the types of samples required for other methods of obtaining substantially the same absorption curve for identical materials.
Official Gazette of the U.S. Patent and Trademark Office

**N90-24151#** California Univ., Santa Barbara. Dept. of Chemistry.
**THEORETICAL STUDIES OF PHOTOCHEMICAL METHODS FOR SEMICONDUCTOR ETCHING Final Report, 1 Oct. - 30 Sep. 1989**
Horia Metiu 1 Jan. 1990 11 p
(AD-A218475) Avail: NTIS HC A02/MF A01 CSCL 20/12

The general theme of the project is the use of photochemical methods for etching semiconductor surfaces or depositing metals on them. There are two aspects to this work: the photochemical process by which the desired molecular or atomic fragments are deposited on the surfaces and the fate of the atoms once deposited (e.g., motion of the atoms on the surface, island growth, sticking probabilities, etc.). GRA

**N90-24152#** Massachusetts Inst. of Tech., Cambridge.
**FUNDAMENTAL AND APPLIED ASPECTS OF DEFECT ENGINEERING IN G2As; EL2 AND OTHER NONSTOICHIOMETRIC DEFECTS Final Report, 15 Feb. - 14 Oct. 1989**
Jacek Lagowski 24 Jan. 1990 5 p
(Ccntract DAAL03-89-K-0043)
(AD-A218597; ARO-26415.1-MS) Avail: NTIS HC A01/MF A01 CSCL 20/2

The work constituted an initial part of a 3 year program on defect engineering in gallium arsenide. This part realized at the Massachusetts Institute of Technology was terminated on October 14, 1989. The work was focused on the role of the EL2 defect and native shallow acceptors in the engineering of GaAs resistivity and thermal conversion characteristics. We have completed a detailed theoretical analysis of the engineering of GaAs resistivity. The results show that all essential GaAs parameters, i.e., the resistivity value, the semiconducting-semi-insulating transition point, and the margin for heavy metal contaminants, could be controlled by controlling the arsenic atom fraction in the melt and/or the rate of crystal cooling between 1000 C and 700 C. GRA

**N90-24153#** State Univ. of New York, Buffalo. Dept. of Chemistry.
**OPTICAL PHONONS AND ELECTRONIC PROPERTIES IN DOUBLE HETEROSTRUCTURES**
D. L. Lin, R. Chen, and Thomas F. George Mar. 1990 21 p
(Contract N00014-90-J-1193)
(AD-A219436; UBUFFALO/DC/90/TR-6) Avail: NTIS HC A03/MF A01 CSCL 20/12

Optical phonon modes in a semiconductor double heterostructure (DHS) are examined within the continuum model. The interface modes found here can account for the novel phenomena observed in right-angle Raman scattering. The Hamiltonian for the electron interaction with phonon eigenmodes is derived and employed to study polaronic effects in the DHS. The 1s-2p + transition energy of a magnetopolaron bound to a hydrogenic impurity in the quantum well is calculated, and excellent agreement with experiments is obtained. GRA

**N90-24154#** Michigan Univ., Ann Arbor. Dept. of Electrical Engineering and Computer Science.
**MOLECULAR BEAM EPITAXIAL GROWTH OF HETEROSTRUCTURES TO STUDY QUANTUM INTERFERENCE PHENOMENA Final Report**
Pallab K. Bhattacharya 1990 6 p
(Contract N00014-88-K-0026)
(AD-A219442) Avail: NTIS HC A02/MF A01 CSCL 20/12

Heterostructure technology has received a tremendous impetus from the rapid advances in crystal growth techniques such as molecular beam epitaxy (MBE). These advances are primarily responsible for the conception and realization of numerous novel concepts and devices. The work reported here involves the MBE growth and regrowth of heterostructures for quantum interference transistors and a detailed study of the physical mechanisms and the limitations imposed by them in such devices. The suitability of the MBE regrowth process for such applications was investigated. Very encouraging progress was made. The performance characteristics of dual-channel quantum interference devices grown in our laboratory and defined by e-beam lithography have been measured and reported. From this work it is clear that to achieve enhanced performance and to demonstrate a large Aharonov-Bohm effect in these materials, etching and regrowth techniques need to be utilized. The regrowth process of these heterostructures was studied and the properties of the regrown materials were characterized. GRA

**N90-24155#** Varian Associates, Palo Alto, CA.
**HIGH TEMPERATURE SUPERCONDUCTIVITY Quarterly Report, for period ending 31 Dec. 1989**
James N. Eckstein 1 Mar. 1990 8 p
(Contract N00014-88-C-0760)
(AD-A219483) Avail: NTIS HC A02/MF A01 CSCL 20/3

The overall goals of this program are to develop the technology of MBE growth of HTSC material, to optimize the performance of HTSC films with high-transition temperatures and critical current densities, and to explore the development of electronic devices based on such material. GRA

**N90-24156#** Paris VI Univ. (France).
**PROCEEDINGS OF A RESEARCH WORKSHOP ON COMPUTATIONAL CONDENSED MATTER PHYSICS. TOTAL ENERGY METHODS AND PHYSICS OF III-V SEMICONDUCTORS**
6 Jan. 1990 40 p Workshop held in Paris, France, 4-6 Jan. 1990
(Contract DAJA45-89-M-0214)
(AD-A219568; ARO-6230-EE-02) Avail: NTIS HC A03/MF A01 CSCL 09/1

One of the breakthroughs in condensed matter physics is the newly acquired ability of theorists to explain and predict properties of solids using quantum theory. Starting with minimal information about the constituent atoms, accurate calculations of electronic, structural, vibrational, and even superconducting properties of solids have been performed. The discussion will provide an overview of this area with emphasis on the predictive capacity of the approach. Applications include the analysis of high pressure structures of solids such as group IV and III-IV semiconductors, metallic hydrogen, and compounds having very low compressibilities. A pseudopotential approach is used in most of the above applications. In some cases empirical theories and scaling laws are employed as a guide to facilitate the investigation of trends in material properties. Specific compounds are suggested as candidates for superhard materials and new superconductors. GRA

**N90-24157#** Oklahoma State Univ., Stillwater. Dept. of Physics.
**PHOTOREFRACTIVE DAMAGE MECHANISMS IN ELECTRO-OPTIC MATERIALS Final Report, Jul. 1985 - Mar. 1989**
Larry E. Halliburton Jan. 1990 54 p
(Grant AF-AFOSR-0270-85; AF Proj. 2305)
(AD-A219786; AFOSR-90-0337TR) Avail: NTIS HC A04/MF A01 CSCL 20/2

Point defects in lithium niobate and related electro-optic materials were characterized using electron paramagnetic resonance (EPR), optical absorption, thermally stimulated luminescence (TSL), and diffusion techniques. In LiNbO3, EPR was used to investigate a radiation-induced trapped-hole center. This new S = 1/2 defect is stable at 77 K but thermally decays near 150 K. Its EPR spectrum exhibits a complex hyperfine equally with three 93 Nb nuclei. It was suggested that the hole is equally shared by a set of three equivalent oxygen ions adjacent to a cation vacancy. The photo-induced redistribution of charge was characterized in Bi12GeO20 and Bi12SiO20 crystals. Optical excitation at 77 K converts Fe (3+) ions to Fe(2+) ions. The source of electrons (i.e., the hole traps) may be other impurities or intrinsic defects such as vacancies or anti-site cations. The intrinsic defects such as vacancies or anti-site cations. The Fe(3+) recovery during warming correlates with thermoluminescence peaks at 145, 165, and 245 K. Results suggest that Fe(3+) ions may play an important role in the photorefractive effect in these materials. In LiTaO3, the EPR spectrum of Ta(4+) ions were investigated. The diffusion coefficients of deuterium in single crystals of LiTaO3 were measured by monitoring the growth of OD (-) infrared absorption bands. GRA

**N90-24158#** Naval Postgraduate School, Monterey, CA. Dept. of Physics.
**EFFECTS OF LARGE DOSES OF HIGH ENERGY ELECTRONS ON A YBa2Cu3O6(+)DELTA HIGH TEMPERATURE SUPERCONDUCTOR M.S. Thesis**
Gregory John Wolfe Dec. 1989 112 p
(AD-A220423) Avail: NTIS HC A06/MF A01 CSCL 20/3

Two samples of YBa2Cu3O6(+) delta high temperature (93 K) superconductor samples were irradiated with 67 MeV electrons. Both samples were cut from the same parent, manufactured by the University of Houston. Radiation effects were studied by measuring resistance as a function of dose during exposure. The samples were exposed to dose up to 100 Mrads. One sample was irradiated at near room temperature, while the second sample was irradiated at 30 K, below the superconducting transition temperature. Resistance as a function of temperature data was obtained prior to and immediately after exposures for both samples. The samples evidenced little or no shifts due to radiation effects in either the normal state resistance or the transition temperature outside of measurement accuracies. Both samples showed evidence of overall crumbling and flaking of the leads, likely due to the continual thermal expansion and contraction of the different materials throughout the different measurements. These mechanical effects produced measurable changes in the normal state resistances. It is concluded that the YBa2Cu3O6(+) delta superconductor is significantly radiation-hard. GRA

**N90-24159#** Maryland Univ., College Park. Dept. of Physics.
**DILUTED MAGNETIC SEMICONDUCTORS Final Report, 1 Apr. 1985 - 31 Dec. 1989**
James R. Anderson 26 Mar. 1990 7 p
(Contract DAAG29-85-K-0052)
(AD-A220444; ARO-22916.15-EL-A) Avail: NTIS HC A02/MF A01 CSCL 09/1

Growth and physical properties of diluted magnetic semiconductors (DMS) were investigated. Growth included Bridgman, solid state recrystallization, and liquid phase epitaxy of Mercury(1-x)Manganese(x)Telluride and Mercury(1-x-y)Manganese(x)Cadmium(y)Telluride. Very uniform crystals were produced by solid state recrystallization. Physical properties studied included magnetization, optical response, and magnetotransport. From magnetization, the exchange interactions among magnetic ions have been deduced. Modulated spectroscopy gave details of the electronic structure of DMS and the quality of the material was indicated by the line widths. Magnetotransport, carried out in some cases to 30 T, showed a large negative magnetoresistance and subsequent increase. The Hg(1-x-y)Mn-(x)Cd(y)Te has considerable promise for avalanche photodiodes between 1.2 and 1.8 micrometers. GRA

**N90-24160*#** Massachusetts Inst. of Tech., Lexington. Lincoln Lab.
**SOLID STATE RESEARCH Quarterly Technical Report, 1 Feb. - 30 Apr. 1989**
Alan L. McWhorter 30 Nov. 1989 101 p Sponsored in part by NASA, Washington, DC; AF; Army; DARPA; Navy; Strategic Defense Initiative Organization; and DOE
(Contract F19628-90-C-0002)
(NASA-CR-186699; NAS 1.24:186699; AD-A220597; Rept-1989-2; ESD-TR-89-146) Avail: NTIS HC A06/MF A01 CSCL 20/12

The partial contents included are: Electrooptical devices -- Theoretical comparison of lumped-element and traveling-wave integrated-optic phase modulators, Comparison of the thermal stability of semi-insulating InP:Fe and InP:Ti:Hg, Wafer fusion by mass transport (A new technique for monolithic integration), Mass Transport of GaInP, and External cavity operation of InGaAsP diode laser arrays; Quantum electronics -- Gain-switched pulsed operation of microchip lasers, Suppression of laser spiking by intracavity second-harmonic generation, Scalable end-pumped Nd:YAG laser, and Lateral-mode structure of external-cavity diode lasers with residual facet reflectivity; Determination of MBE growth rate by digital signal processing of time-dependent RHEED intensity data; Submicrometer technology -- Optical properties of fused silica

exposed to 193-nm radiation from an excimer laser, and Fabrication of regrowth field effect transistor test structures by electron beam lithography; Microelectronics -- Resonant-tunneling oscillators up to 420 GHz, Observation of optically pumped intersubband emission from quantum wells, and Casting process for multichip interconnects; and Analog device technology -- Atomic oxygen source for superconducting films, and Hybrid analog/digital circuitry for superconductive time-integrating correlator. GRA

**N90-24161*#** Massachusetts Inst. of Tech., Lexington. Lincoln Lab.
**SOLID STATE RESEARCH Quarterly Technical Report, 1 May - 31 Jul. 1989**
15 Aug. 1989 86 p Sponsored in part by NASA, Washington, DC; AF; Army; DARPA; Navy; Strategic Defense Initiative Organization; and DOE
(Contract F19628-90-C-0002)
(NASA-CR-186700; NAS 1.24:186700; AD-A220601; Rept-1989-3) Avail: NTIS HC A05/MF A01 CSCL 20/12

The partial contents included are: Electrooptical devices -- High-performance optical analog link using external modulation, 1-Gb/s free-space optical interconnection between digital circuits, and Mass-transported buried-heterostructure GaAs lasers; Quantum electronics -- Single frequency Nd:YAG laser, Laser pumping of solid-state amplifiers using random binary-phase plates, Passively mode-locked Ti:Al2O3 laser using a nonlinear coupled cavity, and Picosecond nondegenerate four-wave mixing in semiconductor waveguides; Materials research -- Total-dose radiation effects on PtSi Schottky-barrier infrared detectors and focal plane arrays; Submicrometer technology -- Aluminum oxides as imaging materials for 193-nm excimer-laser lithography, Planarizing a-C:H and SiO2 films prepared by bias electron cyclotron resonance plasma deposition, and Electrical, crystallographic, and optical properties of ArF-laser-modified diamond surfaces; Microelectronics -- CCD camera developed for wavefront-sensor applications, Surface-state dark-current suppression in CCDs, and Permeable base transistor track-and-hold circuits; and Analog device technology -- Low-loss substrates for high-temperature superconductors, and Multitarget cosputtering of Y1Ba2Cu3Ox superconducting films. GRA

**N90-24162#** State Univ. of New York, Buffalo. Dept. of Chemistry.
**INTERSUBBAND TRANSITIONS IN AN ASYMMETRIC QUANTUM WELL WITH A THIN BARRIER OF A DELTA-FUNCTION POTENTIAL**
L. N. Pandey, Thomas F. George, and M. L. Rustgi Apr. 1990 21 p Submitted for publication
(Contract N00014-90-J-1193)
(AD-A220723; UBUFFALO/DC/90/TR-9) Avail: NTIS HC A03/MF A01 CSCL 20/12

The changes in the bound-state energies and oscillator strength for intersubband transitions brought about by a thin barrier in the middle of an asymmetric quantum well height approaches the bound-state energies. It is found that the oscillator strength goes through a slight change as the barrier height approaches the ground-state energy but an abrupt change when it approaches the excited bound-state energy. A suitable explanation for this change is provided. A similar tailoring of the intersubband transitions is also achieved by placing a delta-function potential in the vicinity of the middle of the well but without any abrupt change in the oscillator strength. GRA

**N90-24163#** Brown Univ., Providence, RI. Dept. of Chemistry.
**PREPARATION AND PROPERTIES OF IRON DOPED II-VI CHALCOGENIDES**
J. DiCarlo, M. Albert, K. Dwight, and A. Wold 29 Mar. 1990 17 p
(Contract N00014-85-K-0177)
(AD-A220802; TR-15) Avail: NTIS HC A03/MF A01 CSCL 20/12

Semi-magnetic semiconductors are a class of doped II-VI compounds which are of interest in the study of magnetic interactions. Samples of iron-doped Zinc Sulfide, Zinc Selenide and Cadmium Sulfide were prepared by the direct combination of the elements. Magnetic measurements indicate that the antiferromagnetic interactions of the iron in the zinc systems were greater than those observed in the cadmium chalcogenides. Single crystals of iron-doped zinc chalcogenides were grown by chemical vapor transport. Their IR transmission was measured and the iron concentration for maximum hardness was determined. GRA

**N90-24164#** State Univ. of New York, Buffalo. Dept. of Chemistry.
**REPLY TO COUPLED S- AND D-WAVE STATES IN THE THORIUM-DOPED HEAVY-FERMION SUPERCONDUCTING UBe13 BY H. PLEINER AND H. R. BRAND**
D. Sahu, A. Langner, and Thomas F. George Mar. 1990 10 p Submitted for publication
(Contract N00014-90-J-1193)
(AD-A220843; UBUFFALO/DC/90/TR-8) Avail: NTIS HC A02/MF A01 CSCL 20/3

The points raised by H. Pleiner and H. R. Brand concerning the earlier work on UBe(13) and thorium-doped UBe(13) are discussed. GRA

**N90-24165#** Stanford Univ., CA. Lab. of Physics.
**ELECTRICAL TRANSPORT THROUGH TUNNEL BARRIERS AND THIN DIELECTRIC LAYERS AND PHYSICAL PROPERTIES OF THE HIGH Tc OXIDE SUPERCONDUCTORS Final Report, 1 Apr. 1983 - 30 Sep. 1989**
M. R. Beasley 26 Mar. 1990 23 p
(Contract N00014-83-K-0391)
(AD-A219860) Avail: NTIS HC A03/MF A01 CSCL 20/3

A broad research program was carried out aimed at the study of advanced superconducting electronic materials, superconducting tunnel junctions and the tunneling process itself. An artificially deposited amorphous silicon tunnel barrier was developed and applied: (1) to tunneling studies of the A15 class superconductors Niobium tin and Vanadium gallium, and (2) to studies of the role of localized states on the tunneling process. The first practical sandwich-type superconducting normal superconducting Josephson junction device was developed based on a Nb-alloyed amorphous silicon barrier materials near a metal/insulator transition. The device appears to be an attractive alternative to shunted tunnel junctions for many applications. Finally, the first practical approach to the deposition of the new high-temperature oxide superconductors was developed, the so-called post-annealed approach, and the materials science of resulting films studied in detail. Tunneling studies of the high-temperature oxide superconductors were also carried out and provided the first evidence for the very large superconductive energy gaps now commonly reported for these materials. GRA

**N90-24166#** Arizona State Univ., Tempe. Center for Solid State Electronics Research.
**HOT CARRIER IN SUBPICOSECOND PHOTOCONDUCTIVE EXPERIMENTS Final Report, 1 Sep. 1984 - 31 Mar. 1989**
Robert O. Grondin 2 Feb. 1990 17 p
(Grant AF-AFOSR-0290-84; AF Proj. 2305)
(AD-A219874; AFOSR-90-0349TR) Avail: NTIS HC A03/MF A01 CSCL 20/12

The goal of this program was the development and use of models of femtosecond photoconductive experiments as probes of hot carrier transport in semiconductors. Prototype experiments were being carried out in a companion effort directed by Dr. Gerald Mourou at the University of Rochester, Rochester, New York. The Arizona State University modeling effort was directed at several main components to the modeling of such experiments. One must first model the generation of electron-hole pairs inside a semiconductor as a result of the incidence of a femtosecond optical pulse. Then one must model the processes by which the resulting current transient is developed. Lastly, the conversion of the current transient into a voltage wave transmitted down a transmission line must be understood. It is this voltage wave that is directly measured in the experiments of interest. Successful models of all three components were developed. GRA

**N90-24167#** Naval Postgraduate School, Monterey, CA.
**EXPERIMENTS ON LIQUID IMMERSION NATURAL CONVECTION COOLING OF LEADLESS CHIP CARRIERS MOUNTED ON CERAMIC SUBSTRATE M.S. Thesis**
Rufino A. Paje Sep. 1989 86 p
(AD-A219893) Avail: NTIS HC A05/MF A01 CSCL 20/13

An experimental investigation of natural convection heat transfer from a commercially available semiconductor device package is presented. The package was centrally mounted on a ceramic substrate. The package-substrate assembly formed one surface of a dielectric-filled cubical enclosure of aspect ratio one. The top surface of the enclosure was maintained at prescribed temperature. Surface temperature measurements were made at various locations on the substrate, the package lid, as well as the chip center. These measurements are reported for three dielectric fluids and three enclosures top surface temperatures, both with the substrate oriented horizontally as well as vertically. The results indicate that the maximum input power without exceeding a chip junction temperature of 80 C is 2.58 watts with FC-75 as the cooling fluid and the upper boundary maintained at 15 C. This is significantly larger than the maximum of 1.21 watts allowable with the natural convection air cooling. GRA

**N90-24168*** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**METHOD OF FORMING A MULTIPLE LAYER DIELECTRIC AND A HOT FILM SENSOR THEREWITH Patent**
Purnell Hopson, Jr., inventor (to NASA) and Sang Q. Tran, inventor (to NASA) 17 Apr. 1990 9 p Filed 1 Apr. 1988 Supersedes N88-25355 (26 - 18, p 2584)
(NASA-Case-LAR-13678-1; US-Patent-4,917,940; US-Patent-Appl-SN-176547; US-Patent-Class-428-216; US-Patent-Class-340-692; US-Patent-Class-428-450; US-Patent-Class-428-457; US-Patent-Class-428-901; Int-Patent-Class-B32B-7/02; Int-Patent-Class-B32B-15/08) Avail: US Patent and Trademark Office CSCL 20L

The invention is a method of forming a multiple layer dielectric for use in a hot-film laminar separation sensor. The multiple layer dielectric substrate is formed by depositing a first layer of a thermoelastic polymer such as on an electrically conductive substrate such as the metal surface of a model to be tested under cryogenic conditions and high Reynolds numbers. Next, a second dielectric layer of fused silica is formed on the first dielectric layer of thermoplastic polymer. A resistive metal film is deposited on selected areas of the multiple layer dielectric substrate to form one or more hot-film sensor elements to which aluminum electrical circuits deposited upon the multiple layered dielectric substrate are connected.
Official Gazette of the U.S. Patent and Trademark Office

**N90-24169*** National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
**CRYSTAL GROWTH APPARATUS Patent**
Frederick T. Herrmann, inventor (to NASA) and Blair J. Herren, inventor (to NASA) 24 Apr. 1990 9 p Filed 29 Feb. 1988 Supersedes N88-25357 (26 - 18, p 2585)
(NASA-Case-MFS-28182-1; US-Patent-4,919,899; US-Patent-Appl-SN-161681; US-Patent-Class-422-245; US-Patent-Class-156-600; US-Patent-Class-156-601; US-Patent-Class-156-607; US-Patent-Class-156-DIG.62; US-Patent-Class-156-DIG.113; US-Patent-Class-422-50) Avail: US Patent and Trademark Office CSCL 20L

This invention relates generally to crystal growth devices, and more particularly to a device in which protein crystals are grown in a hanging drop. The drop is suspended from a surface positioned in the interior of an enclosure which is sealably coupled via a valve to a vessel containing solvent used in the drop. A second opening in the enclosure is coupled via a valve to a vessel containing a selected desiccant material. The valve may be fully or partially opened to add a selected quantity of solvent in a vapor phase to the drop, and the valve may be fully or partially opened to cause a selected quantity of solvent to evaporate from the drop. The process is monitored by a camera, and in conjunction with a graduated pattern superimposed over the drop, relative volumes of the drop are determined. Alternately, the process may be automated by using a computer coupled to servo motors, which in turn are coupled to and operate a cap and valves, respectively. The computer is responsive to a detection device which detects changes of light passing through the drop from the light source.
Official Gazette of the U.S. Patent and Trademark Office

# 77 THERMODYNAMICS AND STATISTICAL PHYSICS

Includes quantum mechanics; theoretical physics; and Bose and Fermi statistics.

For related information see also *25 Inorganic and Physical Chemistry* and *34 Fluid Mechanics and Heat Transfer.*

**N90-24170#** Stockholm Univ. (Sweden). Inst. of Physics.
**FIELDS, PARTICLES, GROUPS: BERTEL LAURENTS 60TH ANNIVERSARY SYMPOSIUM [FAELT, PARTIKLAR OCH GRUPPER: BERTEL LAURENTS 60-AARS SYMPOSIUM]**
1988 69 p Partly in ENGLISH and SWEDISH Symposium held in Stockolm, Sweden, Oct. 29, 1988
(ETN-90-96596) Avail: NTIS HC A04/MF A01

Studies on the following subjects are presented: nonlinear phenomena; chaotic dynamics; quantum mechanics wave propagation to waterwaves; image reconstruction with radar data from a linear aperture; radar data processing in networks systems; the equivalence problem; data processing; mechanical curvature in cosmology; and supersymmetry. ESA

# 80 SOCIAL SCIENCES (GENERAL)

Includes educational matters.

No abstracts in this category.

# 81 ADMINISTRATION AND MANAGEMENT

Includes management planning and research.

**N90-24171#** National Academy of Sciences - National Research Council, Washington, DC. Committee on Promoting Research Collaboration.
**INTERDISCIPLINARY RESEARCH: PROMOTING COLLABORATION BETWEEN THE LIFE SCIENCES AND MEDICINE AND THE PHYSICAL SCIENCES AND ENGINEERING**
1990 49 p
Avail: NTIS HC A03/MF A01

This is a report by the Committee on Promoting Research Collaboration presenting the need for, and the methods for achieving, better communication between researchers in life sciences and medicine, as well as between physical scientists - including mathematicians and computer scientists - and engineers. Advances in one field often can profoundly affect research in another field. The committee identified the general, institutional, educational, financial, and communication factors needed to create an analytic framework for understanding the problems and successes of individuals and groups who conduct interdisciplinary research. Ways of reducing barriers to such collaboration are discussed and specific proposals are made to facilitate communication and exchange. The flow of information across discipline boundaries is urgently needed and strongly recommended. J.P.S.

**N90-24172*#** National Aeronautics and Space Administration, Washington, DC.
**SPACE STATION FREEDOM PRE-WORKSHOP SESSION**
1988 245 p Workshop held in Denver, CO, 25 Oct. 1988
(NASA-TM-102913; NAS 1.15:102913) Avail: NTIS HC A11/MF A02 CSCL 05A

This is a report of a pre-workshop session held before the 1988 Space Station Workshop; it details space station opportunities for commercial users and providers. Aspects covered are: an overview of commercial uses of space; and overview of the Space Station Freedom Program; attributes of space and some practical uses of them; a description of commercial space activities by country, including various statistics; information on each of NASA's Centers for Commercial Development; and monetary and other resources available to help support commercial ventures in space. J.P.S.

**N90-24173*#** National Aeronautics and Space Administration, Washington, DC.
**SMALL BUSINESS INNOVATION RESEARCH PROGRAM SOLICITATION: CLOSING DATE JULY 16, 1990**
1990 122 p
(NASA-TM-101798; NAS 1.15:101798) Avail: NTIS HC A06/MF A01 CSCL 05A

This is the eighth annual solicitation by NASA addressed to small business firms, inviting them to submit proposals for research, or research and development, activities in some of the science and engineering areas of interest to NASA. The solicitation describes the Small Business Innovative Research (SBIR) program, identifies eligibility requirements, outlines the required proposal format and content, states proposal preparation and submission requirements, describes the proposal evaluation and award selection process, and provides other information to assist those interested in participating in NASA's SBIR program. It also identifies the technical topics and subtopics for which SBIR proposals are solicited. These cover a broad range of current NASA interests, but do not necessarily include all areas in which NASA plans or currently conducts research. High-risk high pay-off innovations are desired. Author

**N90-24174*** National Aeronautics and Space Administration, Washington, DC.
**MANAGEMENT: A BIBLIOGRAPHY FOR NASA MANAGERS**
Mar. 1990 190 p
(NASA-SP-7500(24); NAS 1.21:7500(24)) Avail: NTIS HC A09 CSCL 05A

This bibliography lists 755 reports, articles and other documents introduced into the NASA Scientific and Technical Information System in 1989. Items are selected and grouped according to their usefulness to the manager as manager. Citations are grouped into ten subject categories: human factors and personnel issues; management theory and techniques; industrial management and manufacturing; robotics and expert systems; computers and information management; research and development; economics, costs and markets; logistics and operations management; reliability and quality control; and legality, legislation, and policy. Author

**N90-23440** Centre National d'Etudes Spatiales, Toulouse (France).
**IMPLEMENTATION OF LOCATION PROGRAMMES**
Clotaire Pancrate *In its* Location and Navigation Satellite Systems Mar. 1989 p 497-506 In FRENCH; ENGLISH summary (For primary document see N90-23420 17-12)
Copyright Avail: CEPADUES-Editions, 111 rue Nicolas-Vauquelin, 31100 Toulouse, France

# 82 DOCUMENTATION AND INFORMATION SCIENCE

Includes information management; information storage and retrieval technology; technical writing; graphic arts; and micrography.

For computer documentation see *61 Computer Programming and Software.*

**N90-24175#** Sony Corp. of America, Boulder, CO. Technical Operations Center.
**QUICK GUIDE OF THE ESSENTIAL CONCEPTS USED IN OPTICAL DIGITAL DATA DISK TECHNOLOGY**
Jun. 1989 26 p
Avail: NTIS HC A03/MF A01

This Quick Guide covers the definitions of the essential concepts used in optical digital data disk technology. The terms are presented in hierarchical order. The wording of the definitions follows acceptable usage in the field of application as much as possible. Where no concensus has been reached, solutions acceptable to the majority of the International Organization for Standardization (ISO) participants have been included. Author

**N90-24176#** Lockheed Missiles and Space Co., Sunnyvale, CA.
**SPACE STATION FREEDOM: LIST OF ACRONYMS**
1989 58 p
Avail: NTIS HC A04/MF A01

This is a pocket-type reference guide that contains, primarily, an alphabetized list of acronyms related to NASA's Space Station program. It also contains a brief Hardware Development Dictionary; an International System of Units (SI) list of prefixes and their numerical values and symbols; a list of SI unit names and symbols; the chemical elements and their symbols; metric conversion formulas for area, length, power, temperature and velocity/speed; and a list of NASA's official national and foreign offices. J.P.S.

**N90-24177#** Oak Ridge National Lab., TN. Environmental Sciences Div.
**DEVELOPMENT OF A CONSOLIDATED ENVIRONMENTAL DATA BASE**
Larry D. Voorhees 1990 18 p Presented at the Proceedings, Data Analysis and Interpretation for Environmental Surveillance, Lexington, KY, 5-7 Feb. 1990
(Contract DE-AC05-84OR-21400)
(DE90-009419; CONF-9002111-1) Avail: NTIS HC A03/MF A01

A great deal of time, resources, and money has been and continues to be spent on designing and implementing a variety of environmental monitoring programs at US Department of Energy (DOE) facilities. A Federal Facility Agreement between DOE, the US Environmental Protection Agency, and the Tennessee Department of Health and Environment calls for the development of a consolidated environmental data base for the DOE Oak Ridge Reservation (ORR) facilities operated by Martin Marietta Energy Systems, Inc. The objectives of establishing the Energy Systems Environmental Data Base are to ensure long-term retention and accessibility of data collected at all facilities, support the development of a common format for reporting environmental monitoring data, and facilitate the sharing of data in support of environmental compliance and restoration assessments. To achieve these objectives, a Data Management Steering Committee will be established. The committee will define the data management needs; identify the types and sources of data to be maintained; characterize the hardware and software capabilities at each facility; develop a standard data base scheme; and set standards for the contents, quality, and documentation of the data sets. These steps will culminate in the preparation of a Data Management Plan to be implemented at each facility. Major areas of concern include software standards, communications, data collection procedures, data entry, variable naming conventions, chemical nomenclature, units of measurement, levels of precision, date and time formats, spatial coordinates, missing values, quality assurance elements, security, and data exchange formats and procedures. DOE

**N90-24178#** Research Inst. of National Defence, Linkoeping (Sweden). Div. of Information Technology.
**[ACTIVITIES REPORT OF THE DIVISION OF INFORMATIONS SYSTEMS (FOA 37)] Annual Report, Fiscal Year 1988 - 1989**
Gunilla Siverskog, ed. and Eva Toller, ed. Dec. 1989 55 p
(FOA-C-30552-3.4; ISSN-0347-3708; ETN-90-96589) Avail: NTIS HC A04/MF A01; Research Inst. of National Defence, P.O. Box 1165, S-581 11 Linkoeping, Swedish, 50 Swedish crowns

An overview of the work carried out at the Information Systems Division is presented. Research projects, including knowledge based techniques, autonomous systems, computer security, space technology, computer vision, C3I systems, and anti-submarine warfare are described. The computer center and image processing laboratory are outlined. Research exchange, conference contributions and participation, committee participation, seminars and reports are discussed. ESA

**N90-24179#** Technische Univ., Delft (Netherlands). Faculty of Technical Mathematics and Informatics.
**TOWARDS ELEGANT DESIGN OF HIGHLY INTERACTIVE INFORMATION SYSTEMS USING AN OBJECT-ORIENTED APPROACH**
R. C. J. Dur and J. M. Versendaal 1989 18 p Presented at IFIP WG 8.1 Review Workshop of the Framework for Information System Methodologies, Sesimbra, Portugal, 5-8 Jun. 1989
(Rept-89-75; ISSN-0922-5641; ETN-90-96677) Copyright Avail: NTIS HC A03/MF A01

A tripartite design of information systems is proposed, based on a distinction between three elements in the design: a static part, a dynamic part and a projection part. The use of object oriented languages to implement these three parts rather easily and elegantly is demonstrated. The objective of this approach is to decrease the complexity of the system design, due to intense interaction with its users. The design approach is illustrated by modeling a simplified graphical editor. Parts of an implementation of this editor in an object-oriented language are shown. ESA

**N90-24180#** University of Southern California, Marina del Rey. Information Sciences Inst.
**RESEARCH IN KNOWLEDGE DELIVERY Final Report, Nov. 1986 - Oct. 1989**
Eduard H. Hovy 28 Feb. 1990 31 p
(Contract F49620-89-C-0021; AF Proj. 2304)
(AD-A219920; AFOSR-90-0325TR) Avail: NTIS HC A03/MF A01 CSCL 05/7

This report summarizes the research and development work done over four years toward the goal of automatically planning and generating fluent multisentence paragraphs of English text, while ensuring that the grammar is adequate to support the parsing of English text. The work consisted of three principal components, namely text structuring, parsing, and knowledge representation. A theory of texture structure, and an accompanying text planner, were developed and successfully used to generate paragraphs in three different application domains. To ensure bidirectionality, an existing prototype parser was adapted and refined and tested on a functional grammar to investigate the invertibility of the grammar. Knowledge representation work focused on linking the generator with arbitrary applications by developing a very general underlying taxonomy of conceptual entities which can be linked with various specific domain-related taxonomies. GRA

**N90-24181#** Nijmegen Univ. (Netherlands). Dept. of Informatics.
**THE SEMANTICS OF DATA FLOW DIAGRAMS**
P. D. Bruza and T. P. vanderWeide 2 Oct. 1989 16 p Presented at the International Conference on Management Data, 1989
(TR-89-16; ETN-90-96887) Avail: NTIS HC A03/MF A01

Ways in which semantics can be attached to data flow diagrams are described. A method for transforming a Data Flow Diagram (DFD) into a petri net which specificies the synchronization aspects of a DFD is presented. A sketch of how a DFD may be transformed to expressions whose semantics are described in terms of finite automata is presented. The need for further research to provide a general algorithm for the transformation of a DFD to a path expression is stressed. ESA

**N90-24182#** Amsterdam Univ. (Netherlands). Inst. for Language, Logic and Information.
**LANGUAGE IN ACTION**
Johan vanBenthem Jun. 1989 32 p
(ITLI-LP-89-04; ETN-90-96910) Avail: NTIS HC A03/MF A01

Aims are to signal an emerging shift of emphasis in current logical research towards the phenomenon of information processing, to then extract various analogies among different strands involved here, and to propose a suitable general perspective. Language, information, and dynamic paradigms are discussed. Comparisons from logic to relational models and vice versa are given. Various conclusions are detailed. ESA

**N90-24183#** Amsterdam Univ. (Netherlands). Inst. for Language, Logic and Information.
**MODAL LOGIC AS A THEORY OF INFORMATION**
Johan vanBenthem Jun. 1989 33 p
(ITLI-LP-89-05; ETN-90-96911) Avail: NTIS HC A03/MF A01

The prospects of modal logic as a theory of information structure and flow is investigated. This perspective is aimed at the core areas of standard logic and mathematical foundations in the long term. The pattern of information flow, richer formalisms, and information structures, other directions of information processing, and the dynamics of information flow are discussed. ESA

# 83 ECONOMICS AND COST ANALYSIS

Includes cost effectiveness studies.

**N90-24184#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**AN INTERACTIVE LIFE CYCLE COST FORECASTING TOOL M.S. Thesis**
David L. Sumner Mar. 1990 177 p
(AD-A220472; AFIT/GOR/ENS/90M-17) Avail: NTIS HC A09/MF A01 CSCL 05/3

A tool was developed for Monte Carlo simulation of life cycle costs using parametric cost modeling. Additionally, the analysis of the performance of parametric CER cost estimation has been cut down to a more manageable task. Models can be built and tested quickly and easily. Random deviate generators were researched and built. Several applicable statistical description routines were also implemented. Statistical integrity and great accuracy has been maintained, while made accessible through an intuitive, user friendly interface. GRA

# 84 LAW, POLITICAL SCIENCE AND SPACE POLICY

Includes NASA appropriation hearings; aviation law; space law and policy; international law; international cooperation; and patent policy.

**N90-24185#** Office of Technology Assessment, Washington, DC.
**POLAR PROSPECTS: A MINERALS TREATY FOR ANTARCTICA**
Sep. 1989 228 p
(OTA-O-428; LC-89-600718) Avail: NTIS HC A11/MF A02; SOD HC $10.00 as 052-003-01161-1

This report identifies U.S. interests in Antarctica and evaluates the Minerals Convention relative to these interests. It examines the status of knowledge about the resources of Antarctica, the potential impacts of minerals development, and the technical, economic, environmental, geological, and political constraints to development in Antarctica. The report was prepared for the following Congressional Committees: the Senate Committees on

Foreign Relations and on Commerce, Science, and Transportation, and the House Committees on Foreign Affairs and on Merchant Marine and Fisheries. Author

**N90-24186#** Piper and Marbury, Washington, DC.
**THE ENVIRONMENTAL LIABILITIES OF GOVERNMENT CONTRACTORS AND AGENCIES**
Thomas H. Truitt, Susan D. Sawtelle, John J. Duffy, Caryl A. Potter, and Jeffrey F. Liss Oct. 1989 747 p
Avail: NTIS HC A99/MF A04

This is a course manual written by attorneys for government contractors and agencies concerning their legal obligations and liabilities for the environmental impact of their activities. Areas covered include: liabilities for current or past activities; fundamentals of the laws and specific environmental protection acts; the application and enforcement procedures used against government contractors and against Federal, state, and local government; contractor cost recovery policies and mechanics of actions; and insurance coverage issues. Space is provided on each page for the student to add notes. J.P.S.

**N90-24187#** General Accounting Office, Washington, DC.
**SPACE FUNDING: NASA AND DOD ACTIVITIES FOR FISCAL YEARS 1981 THROUGH 1989. FACT SHEET FOR THE CHAIRMAN AND THE RANKING MINORITY MEMBER, SUBCOMMITTEE ON SCIENCE, TECHNOLOGY, AND SPACE, COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION, US SENATE**
Mar. 1989 24 p
(GAO/NSIAD-89-102FS) Avail: NTIS HC A03/MF A01

This is a General Accounting Office report to the Subcommittee on Science, Technology, and Space of the U.S. Senate Committee of Commerce, Science, and Transportation, comparing expenditures on space by NASA and the Department of Defense (DOD). The period covered, fiscal years 1981 through 1989, show approximately equal spending in 1981. For the next five years, DOD experienced a greater increase in spending than NASA, due to DOD's increased reliance on space, and DOD's assumption of responsibility for developing and procuring its own launch systems. This report, which also provides a detailed comparison of NASA's and DOD's spending from fiscal years 1981 through 1989, is an update on a previous report with data from fiscal years 1986 through 1989. J.P.S.

**N90-24188#** Committee on Science, Space and Technology (U.S. House).
**THE 1991 NASA AUTHORIZATION: NATIONAL AERONAUTICS AND SPACE ADMINISTRATION FISCAL YEAR 1991 AUTHORIZATION REQUEST AND BUDGET ESTIMATES**
**Summary Report**
Washington GPO 1990 249 p Presented to the Committee on Science, Space, and Technology, 101st Congress, 2d Session, Mar. 1990
(GPO-27-291) Avail: Subcommittee on Space Science and Applications, House of Representatives, Washington, D.C. 20515 HC free; SOD HC $8.00 as 552-070-07978-5

The fiscal year 1991 budget request is examined for the National Aeronautics and Space Administration programs which include: space station development; space transportation; materials processing in space; commercial use of space; space research and technology; exploration mission studies; academic programs; propulsion systems; launching and landing operations; and communications. This report was prepared by the Subcommittee on Space Science and Applications for the U.S. House of Representatives Committee on Science, Space, and Technology. J.P.S.

**N90-23441** Civil Aviation Authority, London (England).
**NAVIGATION PROGRAMMES: FINANCIAL AND INSTITUTIONAL ASPECTS**
Maurice A. Gamester *In* CNES, Location and Navigation Satellite Systems Mar. 1989 p 507-520 In ENGLISH; FRENCH summary (For primary document see N90-23420 17-12)
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# 85 URBAN TECHNOLOGY AND TRANSPORTATION

Includes applications of space technology to urban problems; technology transfer; technology assessment; and surface and mass transportation.

For related information see also *03 Air Transportation and Safety, 16 Space Transportation,* and *44 Energy Production and Conversion.*

No abstracts in this category.

# 88 SPACE SCIENCES (GENERAL)

**N90-24189#** Astronomische Rechen-Inst., Heidelberg (Germany, F.R.).
**[ACTIVITIES REPORT OF THE INSTITUTE OF ASTRONOMICAL CALCULATIONS] Annual Report, 1988 [TAETIGKEITSBERICHT DES ASTRONOMISCHEN RECHEN-INSTITUTS IN HEIDELBERG FUER DAS JAHR 1988]**
R. Wielen 1988 17 p In GERMAN
(ETN-90-96461) Avail: NTIS HC A03/MF A01

Several books which were published are described: Astronomic fundamental for the calendar, Apparent places of fundamental stars, Astronomy and astrophysics abstracts. The main research areas were: astrometry (Hipparcos and Tycho projects), structure, kinematics, dynamics and development of star systems (Milky Way, galaxies) and sky mechanics. ESA

# 89 ASTRONOMY

Includes radio, gamma-ray, and infrared astronomy, and astrometry.

**N90-24190#** Cambridge Univ. (England). Inst. of Astronomy.
**INSTITUTE OF ASTRONOMY Annual Report, 1988 - 1989**
1989 55 p
Avail: NTIS HC A04/MF A01

Activities are reported in the study of: the sun and solar system; stars and stellar evolution; galaxies; galactic structure; galactic clusters and their origins; quasars; astronomical telescopes and other instruments. J.P.S.

**N90-24191** Max-Planck-Inst. fuer Physik und Astrophysik, Garching (Germany, F.R.). Inst. fuer Extraterrestrial Physik.
**OBSERVATIONS OF CYGNUS X-2 AT X RAY, UV, OPTICAL AND RADIO FREQUENCIES**
Oct. 1989 129 p Submitted for publication
(MPE-Preprint-163; ETN-90-96469) Copyright Avail: Fachinformationszentrum Karlsruhe, 7514 Eggenstein-Leopoldshafen 2, Fed. Republic of Germany

The observations of the x ray binary Cygnus X-2 are reported. They were performed with the Japanese x ray satellite Ginga, IUE and other ground-based optical and radio instruments, during the observing campaigns 10 to 14 Jun. and 6 to 9 Oct. 1988 at x ray, ultraviolet, optical and radio frequencies. The problem of the variation of the mass accretion rate along Z-shape correlation curve are discussed. The results of the stellar spectra along the horizontal branch are discussed. The implications of the observation campaign results are analyzed. For individual titles, see N90-24192 through N90-24195.

**N90-24192** Max-Planck-Inst. fuer Physik und Astrophysik, Garching (Germany, F.R.).
**MULTIFREQUENCY OBSERVATIONS OF CYG X-2: X RAY OBSERVATIONS WITH GINGA**
Guenther Hasinger, M. vanderKlis, K. Ebisawa, T. Dotani, and K. Mitsuda (Tokyo Univ., Sagamihara, Japan ) *In its* Observations of Cygnus X-2 at X Ray, UV, Optical and Radio Frequencies Oct. 1989 p 1-45 Revised (For primary document see N90-24191 17-89)
Copyright Avail: Fachinformationszentrum Karlsruhe, 7514 Eggenstein-Leopoldshafen 2, Fed. Republic of Germany

The observations of the bright low-mass x ray binary and Z-source Cyg X-2, carried out with the Japanese x ray satellite Ginga, are reported. The observations were effectuated for six days in 1988 June and October at x ray, ultraviolet, optical and radio wavelengths. On both occasions all three spectral states, the horizontal, normal and flaring branch, showing up as a Z-shaped correlation curve in an x ray color-color diagram, were observed. Quasi-Periodic Oscillations (QPO) and noise are detected. The sudden disappearance of the radio flares, hand in hand with the decrease of QPO and noise power and the softening of the x ray spectra at the transition from horizontal branch to normal branch can be interpreted in terms of a sudden inflation of the inner disk, which engulfs the entire magnetosphere in the normal branch. ESA

**N90-24193*** Harvard-Smithsonian Center for Astrophysics, Cambridge, MA.
**OBSERVATIONS OF CYGNUS X-2 WITH IUE: ULTRAVIOLET RESULTS FROM A MULTIWAVELENGTH CAMPAIGN**
S. D. Vrtilek, J. C. Raymond, M. R. Garcia, F. Verbunt, Guenther Hasinger (Max-Planck-Inst. fuer Physik und Astrophysik, Garching, Germany, F.R. ), and M. Kuerster *In* Max-Planck-Inst. fuer Physik und Astrophysik, Observations of Cygnus X-2 at X Ray, UV, Optical and Radio Frequencies Oct. 1989 p 46-88 (For primary document see N90-24191 17-89)
(Grant NAG5-87)
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The observations of the low-mass x ray binary, Cyg X-2, taken with the International Ultraviolet Explorer (IUE) in a campaign conducted in June and October of 1988 are reported. A direct relationship between the strength of the UV continuum and line emission and the placement of the x ray spectrum in one of three branches of the so-called Z-shaped curve is found by comparison with simultaneous x ray observations. All three previously known x ray spectral states are detected; the UV continuum and line emission increase monotonically along the Z with the least emission in the horizontal branch, and the most in the flaring branch. Emission lines due to HeII, CIV, NIII, NIV, NV, SiIV, and MgII are observed. ESA

**N90-24194** Amsterdam Univ. (Netherlands). Astronomical Inst.
**OPTICAL SPECTROSCOPY OF V1341 CYG, THE OPTICAL COUNTERPART OF CYG X-2**
J. vanParadijs, J. Allington-Smith, P. Callanan, P. A. Charles, B. J. M. Hassall, G. Machin, K. O. Mason, T. Naylor, and A. P. Smale (Mullard Space Science Lab., Dorking, England ) *In* Max-Planck-Inst. fuer Physik und Astrophysik, Observations of Cygnus X-2 at X Ray, UV, Optical and Radio Frequencies Oct. 1989 p 89-102 (For primary document see N90-24191 17-89)
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The results of spectroscopic observations of the optical conterpart of Cyg X-2 are presented. They were performed using the William Herschel Telescope between June 9 and 27, 1988, comprising x ray, ultraviolet, optical and radio observations. The properties of the emission lines in the optical spectrum show large variations, which do not appear to be correlated with the orbital phase. A comparison with (near-)simultaneous x ray data shows the HeII lambda 4686 and the Bowen lambda 4630 emission lines become stronger as the x ray source moves from the horizontal branch towards the flaring branch of the Z-shaped track in the x ray color-color diagram. The possible implications of this result are discussed. ESA

**N90-24195** National Radio Astronomy Observatory, Socorro, NM.
**RADIO OBSERVATIONS OF THE X RAY BINARY CYGNUS X-2**
R. M. Hjellming, Xiao HongHan, F. A. Cordova, and Guenther Hasinger (Max-Planck-Inst. fuer Physik und Astrophysik, Garching, Germany, F.R. ) *In* Max-Planck-Inst. fuer Physik und Astrophysik, Observations of Cygnus X-2 at X Ray, UV, Optical and Radio Frequencies Oct. 1989 p 103-126 (For primary document see N90-24191 17-89)
(Grant NSF AST-88-14515)
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The observations of the x ray binary Cyg X-2 are reported. They were performed with Ginga X-ray satellite, IUE and ground based optical and radio instruments, in 1988 June 10 to 14 and 1988 October 6 to 9. An apparent correlation between the behavior of this object in the observed wavelengh regions (1.49, 4.9 and 8.4) is established. Data supports the conclusion that Cyg X-2 has radio quiet states. Two hypothetical scenarios for a relationship between radio and x ray emission in Cyg X-2 are discussed. ESA

**N90-24196** Max-Planck-Inst. fuer Physik und Astrophysik, Garching (Germany, F.R.). Inst. fuer Extraterrestrische Physik.
**CONTRIBUTIONS OF THE X RAY ASTRONOMY GROUP OF THE MAX-PLANCK-INSTITUT FUER EXTRATERRESTRISCHE PHYSIK**
Nov. 1989 53 p Proceedings of the 23rd ESLAB Symposium on X Ray Astronomy, Bologna, Italy, 13-20 Sep. 1989
(MPE-Preprint-165; ETN-90-96470) Copyright Avail: Fachinformationszentrum Karlsruhe, 7514
Eggenstein-Leopoldshafen 2, Fed. Republic of Germany

Investigations carried out on extraterrestrial physics by the x ray astronomy group of the Max Planck Institute are reported. The topics presented are: the spectrum analysis of supernova SN 1987A, obtained by the High Energy X ray Experiment (HEXE) on Mir-Kvant module; the observations performed by HEXE of black hole candidates. The observations made by Exosat are included: the study of soft x ray spectrum of Cyg X-1; the study of the noise variability in the Cyg X-1 and Her X-1 spectra; the observations of the pulse profile of Her X-1 in a 35-day-cycle in 1985; the pulsed light curve of Vela X-1; the observations of the LMC X-4 region and its spectral variability; and the analysis of the spectra of the quasi-periodic-oscillation sources. For individual titles, see N90-24197 through N90-24205.

**N90-24197** Max-Planck-Inst. fuer Physik und Astrophysik, Garching (Germany, F.R.). Inst. fuer Extraterrestrische Physik.
**MIR-KVANT-HEXE HARD X RAY LIGHT CURVE OF SN 1987A**
J. Englhauser, S Doebereiner, W. Pietsch, C. Reppin, J. Truemper, E. Kendziorra, M. Maisack, B. Mony, R. Staubert, and V. V. Efremov (Academy of Sciences, USSR, Moscow ) et al *In its* Contributions of the X Ray Astronomy Group of the Max-Planck-Institut fuer Extraterrestrische Physik Nov. 1989 p 1-4 (For primary document see N90-24196 17-89)
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The observations of supernova 1987A, performed by High Energy X ray Experiment (HEXE) on board of the Mir-Kvant module, are reported. A total observation time of 530,000 s was spent on that target, and data are available from day 144 to 843 after the outburst. Comparison with published results, data from four detectors, and improved background subtraction method are considered. A final energy calibration is established. Hard x ray flux from SN 1987A are discovered. X ray light curves are presented in three energy bands, extending the time coverage to June 1989. The new results confirm the results published. ESA

**N90-24198** Max-Planck-Inst. fuer Physik und Astrophysik, Garching (Germany, F.R.). Inst. fuer Extraterrestrische Physik.
**OBSERVATIONS OF BLACK HOLE CANDIDATES WITH THE MIR-KVANT HEXE**
S. Doebereiner, J. Englhauser, W. Pietsch, C. Reppin, J. Truemper, E. Kendziorra, M. Maisack, B. Mony, R. Staubert, and V. V. Efremov (Academy of Sciences, USSR, Moscow ) et al *In its* Contributions of the X Ray Astronomy Group of the Max-Planck-Institut fuer Extraterrestrische Physik Nov. 1989 p 5-10 (For primary document see N90-24196 17-89)
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The spectra and light curves, obtained with improved data processing techniques, of black hole candidates are presented. The three black hole candidates Cygnus X-1.GX339-4, and the x ray transient source GS2000+25 were observed with the High Energy X ray Experiment (HEXE) aboard the Soviet space station MIR. The spectra of Cygnus X-1 and GS2000+25 in the energy range from 30 to 180 keV deviate significantly from simple power laws and are compatible with either thermal bremsstrahlung from a hot and optically thin plasma or low energy photons comptonized to high x ray energies in a hot plasma cloud. ESA

**N90-24199** Max-Planck-Inst. fuer Physik und Astrophysik, Garching (Germany, F.R.). Inst. fuer Extraterrestrische Physik.
**EXOSAT OBSERVATIONS OF CYGNUS X-1: STUDY OF THE SOFT X RAY EXCESS**
Monika Balucinska (Polish Academy of Sciences, Warsaw.) and Guenther Hasinger *In its* Contributions of the X Ray Astronomy Group of the Max-Planck-Institut fuer Extraterrestrische Physik Nov. 1989 p 11-16 (For primary document see N90-24196 17-89)
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Ten observations of Cygnus X-1 made by the EXOSAT medium energy experiment, in the period of 1984 to 1985 when the source was in its low state, are examined. The presence of a soft component (black body temperature of around 0.2 keV), on top of high energy power law component, is confirmed in all spectra. The emission line at 6.2 keV is also visible and its intensity varies during the dips. The soft component undergoes more distinct fluctuations than the hard one, which is well seen on a color-color and a color-intensity diagram. The results are discussed in the framework of an accretion disc model. ESA

**N90-24200** Max-Planck-Inst. fuer Physik und Astrophysik, Garching (Germany, F.R.). Inst. fuer Extraterrestrische Physik.
**NOISE VARIABILITY IN CYG X-1 AND HER X-1**
Tomaso Belloni and Guenther Hasinger *In its* Contributions of the X Ray Astronomy Group of the Max-Planck-Institut fuer Extraterrestrische Physik Nov. 1989 p 17-21 (For primary document see N90-24196 17-89)
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The aperiodic variability in the x ray emission of Cyg X-1 and Her X-1 is examined from EXOSAT archive data by means of the production of broad band power spectra. The power spectra of Cyg X-1 is analyzed and show a complex shape and variations of the break frequency over one order of magnitude. Good agreement with the data is obtained using a shot noise model with a distribution in shot lifetimes. The noise in Her X-1 shows variations correlated with the 35d cycle of the source. The observations are consistent with occultation by the inner accretion disk. ESA

**N90-24201** Max-Planck-Inst. fuer Physik und Astrophysik, Garching (Germany, F.R.). Inst. fuer Extraterrestrische Physik.
**EXOSAT OBSERVATIONS OF THE PULSE PROFILE OF HER X-1 DURING INTERMEDIATE INTENSITY STATES IN A 35-DAY-CYCLE IN 1985**
Peter Kahabka *In its* Contributions of the X Ray Astronomy Group of the Max-Planck-Institut fuer Extraterrestrische Physik Nov. 1989 p 22-27 (For primary document see N90-24196 17-89)
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The observations of the Her X-1 performed by EXOSAT during two 35-day-cycles, in 1984 and 1985, are reported. A pulse profile change was observed and modeled by a free precessing neutron star (NS). It is shown that the progressive intensity reduction from the left to the right pulse flank of the main pulse can be described by highly ionized obscurating screen at the inner magnetospheric boundary of the accetion disk with a scale height of approximately 2 x 10(exp 6)/cm. A sideward tilt of approximately 60 degrees of the NS rotation axis accounts for the vertical movement of the poles of the NS causing the asymmetric obscuration of the main pulse. Further evidence that the Her X-1 performs a free precession movement is analyzed. ESA

**N90-24202** Max-Planck-Inst. fuer Physik und Astrophysik, Garching (Germany, F.R.). Inst. fuer Extraterrestrische Physik.
**THE PULSED LIGHT CURVE OF VELA X-1**
B. C. Raubenheimer (Potchefstroom Univ. for Christian Higher Education, South Africa ) *In its* Contributions of the X Ray Astronomy Group of the Max-Planck-Institut fuer Extraterrestrische Physik Nov. 1989 p 28-32 (For primary document see N90-24196 17-89)
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The 283 second pulse profile of Vela X-1 and its dependence on spin and orbital phase and energy are investigated. Low and medium energy data from EXOSAT observatory are analyzed. Pulsed emission was found down to the lowest energy measurable (0.7 to 2 keV). A pulse phase analysis showed that the pulse profiles are independent of the orbital phase and on time scales larger than 4 hours. It is shown that the five low energy peaks evolve gradually out of the double peak structure at high energies and that the transition occur in the 6 to 20 keV range. Comparison with existing models led to conclude that the neutron star is a near-orthogonal rotator with the magnetic axis close to the line of sight and that the x rays must be produced in slightly asymmetric accretion columns at the magnetic poles. These columns consist of cold, highly magnetized plasma. The energy region in which the pulse shape transformation took place indicate a magnetic field of 2-5 x 10(exp 12) G. ESA

**N90-24203** Max-Planck-Inst. fuer Physik und Astrophysik, Garching (Germany, F.R.). Inst. fuer Extraterrestrische Physik.
**EXOSAT DEEP EXPOSURE OF THE LMC X-4 REGION**
W. Pietsch, Konrad Dennerl, and C. Rosso *In its* Contributions of the X Ray Astronomy Group of the Max-Planck-Institut fuer Extraterrestrische Physik Nov. 1989 p 33-37 (For primary document see N90-24196 17-89)
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The EXOSAT observations of the LMC X-4 region, obtained during more than 70h observing time from 1983 to 1986, are examined. The observations were performed with the low energy x ray telescope and channel multiplier array and 3000 angstrom Lexan filter are combined into one image. The supernova remnants N49 and N63A and the Me star LHG57 are detected in the EXOSAT image and in addition the x ray source EXO 053109-6609.2. This EXOSAT LMC transient is only visible during 1983. The star HD37935, the emission nebulae N55 and N55A, a stellar association near N62A, the star cluster NGC2003 are also shown, however, they are not detected due to UV radiation leaking through the filter. ESA

**N90-24204** Max-Planck-Inst. fuer Physik und Astrophysik, Garching (Germany, F.R.). Inst. fuer Extraterrestrische Physik.
**SPECTRAL VARIABILITY OF LMC X-4**
Konrad Dennerl *In its* Contributions of the X Ray Astronomy Group of the Max-Planck-Institut fuer Extraterrestrische Physik Nov. 1989 p 38-43 (For primary document see N90-24196 17-89)

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EXOSAT observations of the LMC X-4 region are reported. It is shown that the mean spectrum of LMC X-4, during the on state, is characterized by a hard power low with a high energy cut-off, a soft energy excess, and an iron emission line. During a very bright flare the spectrum was found to change the thermal bremsstrahlung. Pulse phase spectroscopy during this flare reveals the existence of two iron lines which change their separation with pulse phase and with the intensity of the continuum. The behavior is consistent with the assumption of symmetrical Doppler shifting. During other flares instantaneous phase shifts by approximately 180 deg are detected in the pulse profile. The consequences of these observations are discussed and compared to the situation in Her X-1. ESA

**N90-24205** Max-Planck-Inst. fuer Physik und Astrophysik, Garching (Germany, F.R.). Inst. fuer Extraterrestrische Physik.
**THE ROLE OF COMPTONISATION IN ENERGY SPECTRA OF STANDARD QPO-SOURCES**
N. S. Schulz and R. A. M. J. Wijers (Amsterdam Univ., Netherlands ) *In its* Contributions of the X Ray Astronomy Group of the Max-Plank-Institut fuer Extraterrestrische Physik Nov. 1989 p 44-49 (For primary document see N90-24196 17-89)
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The spectral variability of Quasi-Periodic Spectral (QPO) sources is analyzed from EXOSAT data. It is found that blackbody comptonized by hot electron plasma fit the EXOSAT spectra of these sources. The fit is as accurate as using two component spectral models. This equivalency is observed within all spectral branches. A parametrization of the color-color diagram indicates systematical parameter variatioris in all spectral branches. They can be decomposed in a variation of single photon source and an extended hot electron cloud. The temperature of the photon source varies between 0.5 and 1.0 keV, the electron cloud has scattering depths between 3 and 7 and temperatures from 2.0 to 5.0 keV. Links to QPO-models on the horizontal spectral branch and physical consequences of the model are discussed. ESA

**N90-24206#** Naval Postgraduate School, Monterey, CA. Dept. of Administrative Sciences.
**THE INFLUENCE OF CONTRACT TYPE IN PROGRAM EXECUTION/V-22 OSPREY: A CASE STUDY M.S. Thesis**
Danny Roy Smith Dec. 1989 78 p Sponsored by Naval Air Systems Command, Washington, DC
(AD-A220011) Avail: NTIS HC A05/MF A01 CSCL 01/3

The purpose of this study was to look at the impact of a fixed price type contract on program execution of a major weapon system. The full scale development phase of the V-22 Osprey program was used as a case study. The focus of this thesis was to determine the affects of this contract type and identify the actions program management took to address it's influences. The predominant conclusion brought out by this research was that based on the political, historical, and economic circumstances of the period, the fixed price incentive fee contract was the best contractual instrument for the government to use. The major recommendations are: in future contracts, ensure an appropriate spread between ceiling and target price in order to adequately incentivize the contractor; in teaming arrangements, employ incentives to guarantee the appropriate transfer of technical information; and incentivize comprehensive production plans and Production Readiness Reviews. GRA

# 90 ASTROPHYSICS

Includes cosmology; celestial mechanics; space plasmas; and interstellar and interplanetary gases and dust.

For related information see also *75 Plasma Physics*.

**N90-24207** California Univ., Berkeley.
**MOLECULAR STUDIES OF DENSE CORES Ph.D. Thesis**
Gary Anthony Fuller 1989 285 p
Avail: Univ. Microfilms Order No. DA9006328

Observations of 17 different dense cores in nearby molecular clouds are presented. Most of these cores were mapped in both the C(18)OJ = 1 yields 0 spectral line and the J = 2 yields 1 of CS. Additional observations of the J = 1 yields 0 transition of CS are also presented. The properties of the cores as determined from these molecules is compared to those derived from existing NH3 observations of the same cores. Both the CS and C(18)O emission are more extended than the NH3 emission and therefore presumably trace lower density gas. It was initially thought that the CS should trace very dense gas, but a radiative transfer calculation, assuming that the emission arises from a two density component model of the core, demonstrates that the observed core size could result from the effects of a low density envelope around a very dense core when observed with an angular resolution insufficient to fully resolve the very dense gas. Seven of the cores mapped were selected on the basis of IRAS observations because they did not have any associated infrared sources. The remaining ten cores all have low luminosity (L less than 16 solar luminosity) infrared sources close to the region of ammonia emission. Cores with infrared sources are found to have higher column densities, broader linewidths and brighter CS J = 2 yields 1 lines than the starless cores. The results of a high spectral and spatial resolution study of one of the cores mapped in CS and C(18)O, B5, are also presented. Using the Hat Creek Interferometer to observe the J = 1 yields 0 emission of HCN, three clumps are detected near the star. Two of these clumps may be part of a circumstellar disk around the infrared source. However, it is also possible that the clumps are the result of the action of the outflow from this source, and do not reflect the original distribution of the dense circumstellar material. It is also demonstrated for this source that foreground, low density material can have a significant effect on the emission from the central regions of the core. Author

**N90-24208** Case Western Reserve Univ., Cleveland, OH.
**ABUNDANCE DIFFERENCES AMONG G AND K GIANTS Ph.D. Thesis**
Sharon Lynn Montgome Challener 1989 145 p
Avail: Univ. Microfilms Order No. DA9004498

Effective temperatures and surface gravities were derived for 52 G and K giants using model atmosphere. Of these, 33 were called very strong-lined (or VSL) stars primarily because of their CN line strength. We find that when compared to normal stars, the VSL stars show a mean iron overabundance of 0.15 dex. Contrary to earlier suggestions, none of the heavier elements (Z greater than 10) appear selectively enhanced. Red giants are believed to undergo mixing, thereby driving the surface abundances towards those of the stellar interior. Carbon, nitrogen, and oxygen abundances are most sensitive to mixing as they are produced through nucleosynthesis at various depths beneath the star's surface. The CNO abundances (normalized to the iron abundances) of the VSLs appear on average to be normal for G and K giants. This result suggests that the strong CN absorption seen in VSLs is not the result of unusual mixing. Their general overabundance of metal appears instead to be innate, presumably reflecting the metallicity of the gaseous clouds from which they formed. This should be settled once the appropriate number of VSL dwarfs is found. The deviations from the normal population of giants are rather small, however, and certainly not of the magnitude envisioned by Spinrad and Taylor (1969). It is likely that VSLs are merely the stars lying in the tail of the normal abundance distribution.
Dissert. Abstr.

**N90-24209** Illinois Univ. at Urbana-Champaign, Savoy.
**MOLECULAR GAS IN S106: MORPHOLOGY, KINEMATICS, AND CHEMISTRY OF A STAR FORMING REGION Ph.D. Thesis**
Robert Stephen Loushin 1989 170 p
Avail: Univ. Microfilms Order No. DA9010941

The biconical H II region S106 is a site of recent star formation; it consists of two ionized lobes flowing out from a central disk of cold molecular gas in which is embedded the newly formed massive

star IRS 4. This entire complex is still embedded in the molecular cloud from which it formed. It was found that the central disk is expanding at 2 km/s and that clumps of molecular material are being ablated from its surface by the ionized ouflow and accelerated to higher velocities. The ring is not rotating and may be supported by magnetic field pressure or the pressure of the ionized outflow. The origin and initial collimation of the ionized outflow remains unclear but must be occurring relatively near IRS 4. It is argued that for distances from IRS 4 larger than 5 sec, the kinematics of the outflow is very large, on the order of 1 mG. Finally, it is shown that there is a clear chemical evolution through the shock front between the ionized and molecular gas, with the HCO(+)/CS ratio being greatly enhanced at the interface. Dissert. Abstr.

**N90-24210** Kent Univ., Canterbury (England).
**DUST ENVIRONMENT MODELLING FROM ENCOUNTERS WITH COMET P/HALLEY Ph.D. Thesis**
George S. Pankiewicz 1989 273 p
Avail: Univ. Microfilms Order No. BRDX87926

The first in situ measurements of a cometary dust coma were made possible in March 1986 with the encounters of comet P/Halley by Vega 1, Vega 2 and Giotto. To describe and predict the coma dust environment experienced by the spacecraft, a computer model was produced using pre-existing data concerning nucleus characteristics, dust grain properties and near nucleus and outer coma dust dynamics. Fluxes and fluences were computed for a variety of masses for all three flybys and the likelihood of count rate saturation for dust impact sensors and spacecraft survival was explored. Dust experiments on board the Giotto spacecraft measured the mass distribution in the range 10 (exp-18) kg to 10 (exp-5) kg. The dust impact detector system (DIDSY) measured the largest part of this spectrum (less than or equal 4 x 10 (exp -14) kg), using microphonic, plasma and penetration detectors. The final experimenter's tape was used to create a working sourcefile (COMPACT), and reduction of the accumulated counts from DIDSY was performed to obtain measured fluxes and fluences for model comparison. Analysis of Vega SP-2 and Giotto DIDSY and PIA data is given. A method to simultaneously determine comet Halley's rotation state and map the emission centers in a nucleus coordinate system is described and assessed for a sample of the Giotta DIDSY data. Author

**N90-24211*#** Chicago Univ., IL. Dept. of Physics.
**EVOLUTION OF LIGHT DOMAIN WALLS INTERACTING WITH DARK MATTER, PART 1**
Alessandro Massarotti Apr. 1990 19 p Prepared in cooperation with Fermi National Accelerator Lab., Batavia, IL Sponsored in part by DOE
(Grant NAGw-1340)
(NASA-CR-181123; NAS 1.26:181123; FERMILAB-Pub-90/77-A)
Avail: NTIS HC A03/MF A01 CSCL 03B

The evolution of domain walls generated in the early Universe is discussed considering an interaction between the walls and a major gaseous component of the dark matter. The walls are supposed able to reflect the particles elastically and with a reflection coefficient of unity. A toy Lagrangian that could give rise to such a phenomenon is discussed. In the simple model studied, highly non-relativistic and slowly varying speeds are obtained for the domain walls (approximately 10 (exp -2)(1+z)(exp -1)) and negligible distortions of the microwave background. In addition, these topological defects may provide a mechanism of forming the large scale structure of the Universe, by creating fluctuations in the dark matter (delta rho/rho approximately O(1)) on a scale comparable with the distance the walls move from the formation (in the model d less than 20 h(exp -1) Mpc). The characteristic scale of the wall separation can be easily chosen to be of the order of 100 Mpc instead of being restricted to the horizon scale, as usually obtained. Author

**N90-24212*#** Illinois Univ., Chicago.
**PROBING THE BIG BANG WITH LEP**
David N. Schramm Jun. 1990 27 p Presented at the La Thuile Workshop, Mar. 1990 Prepared in cooperation with Fermi National Accelerator Lab., Batavia, IL Sponsored in part by DOE
(Grants NAGw-1340; NAGw-1321; NSF AST-88-22595)
(NASA-CR-181060; NAS 1.26:181060; FERMILAB-Conf-90/120-A)
Avail: NTIS HC A03/MF A01 CSCL 03B

It is shown that LEP probes the Big Bang in two significant ways: (1) nucleosynthesis, and (2) dark matter constraints. In the first case, LEP verifies the cosmological standard model prediction on the number of neutrino types, thus strengthening the conclusion that the cosmological baryon density is approximately 6 percent of the critical value. In the second case, LEP shows that the remaining non-baryonic cosmological matter must be somewhat more massive and/or more weakly interacting than the favorite non-baryonic dark matter candidates of a few years ago. Author

**N90-24213*#** Illinois Univ., Chicago. Dept. of Physics.
**THERMAL RELICS: DO WE KNOW THEIR ABUNDANCES**
Marc Kamionkowski and Michael S. Turner May 1990 31 p Prepared in cooperation with Fermi National Accelerator Lab., Batavia, IL Sponsored in part by DOE
(Grant NAGw-1340)
(NASA-CR-183334; NAS 1.26:183334; FERMILAB-Pub-90/97-A)
Avail: NTIS HC A03/MF A01 CSCL 03B

The relic abundance of a particle species that was once in thermal equilibrium in the expanding Universe depends upon a competition between the annihilation rate of the species and the expansion rate of the Universe. Assuming that the Universe is radiation dominated at early times the relic abundance is easy to compute and well known. At times earlier than about 1 sec after the bang there is little or no evidence that the Universe had to be radiation dominated, although that is the simplest and standard assumption. Because early-Universe relics are of such importance both to particle physics and to cosmology, three nonstandard possibilities are considered in detail for the Universe at the time a species' abundance froze in: energy density dominated by shear (i.e., anisotropic expansion), energy density dominated by some other nonrelativistic species, and energy density dominated by the kinetic energy of the scalar field that sets the gravitational constant in a Brans-Dicke-Jordan cosmological mode. In the second case the relic abundance is less than the standard value, while in the other two cases it can be enhanced by a significant factor. Two other more exotic possibilities for enhancing the relic abundance of a species are also mentioned--a larger value of Newton's constant at early times (e.g., as might occur in superstring or Kaluza-Klein theories) or a component of the energy density at early times with a very stiff equation of state (p greater than rho/3), e.g., a scalar field phi with potential V(phi) = Beta /phi/ (exp n) with n greater than 4. Results have implications for dark matter searches and searches for particle relics in general. Author

**N90-24214*#** Sussex Univ., Brighton (England). School of Mathematical and Physical Sciences.
**CLASSICAL THEORY OF RADIATING STRINGS**
Edmund J. Copeland, D. Haws, and M. Hindmarsh (Newcastle Univ., England ) Jun. 1990 12 p Sponsored in part by DOE and by SERC (UK)
(Grant NAGw-1340)
(NASA-CR-186607; NAS 1.26:186607; FERMILAB-Pub-90/119-A; NCL-TP-90/1; SX-TP-90.1) Avail: NTIS HC A03/MF A01 CSCL 03B

The divergent part of the self force of a radiating string coupled to gravity, an antisymmetric tensor and a dilaton in four dimensions are calculated to first order in classical perturbation theory. While this divergence can be absorbed into a renormalization of the string tension, demanding that both it and the divergence in the energy momentum tensor vanish forces the string to have the couplings of compactified N = 1 D = 10 supergravity. In effect, supersymmetry cures the classical infinities. Author

# 91 LUNAR AND PLANETARY EXPLORATION

Includes planetology; and manned and unmanned flights.

For spacecraft design or space stations see *18 Spacecraft Design, Testing and Performance.*

**N90-24215#** Swedish Inst. of Space Physics, Kiruna.
**ACTIONS OF MAGNETOSPHERES ON PLANETARY ATMOSPHERES**
Bengt Hultqvist Dec. 1989 41 p Presented at the IAGA Scientific Assembly Symposium on Planetary Magnetospheres, Exeter, England, 24 Jul. - 4 Aug. 1989
(IRF-SR-203; ISSN-0284-1703; ETN-90-96578) Avail: NTIS HC A03/MF A01

Observed characteristics of the interactions of the magnetospheres on the planetary atmospheres of Earth, Mars, Jupiter, Uranus and Saturn are summarized. Tables containing the estimated order of magnitude of power associated with auroral particle precipitation and Joule heating and of ionospheric ion outward fluxes arrived at are given. Measurements from Viking, Phobos and Voyager missions are used. The auroral emission intensity of Earth is second only to that of Jupiter which is extreme in most respects. For planets with a corotating plasmasphere extending to the magnetopause, the Joule heating power is small compared with the precipitating particle power. ESA

**N90-24216#** Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.).
**PROJECT GALILEO: RECOGNITION OF THE PLANET JUPITER AND ITS MOONS [PROJEKT GALILEO: ERKUNDUNG DES PLANETEN JUPITER UND SEINER MONDE]**
11 Oct. 1989 7 p In GERMAN
(Rept-42/89; ETN-90-96448) Avail: NTIS HC A02/MF A01

The Galileo mission, part of the NASA Lunar and Planetary Exploration Program, which is intended to put a space vehicle in orbit and to introduce an entry probe into the atmosphere of Jupiter is outlined. The chemical composition and the dynamic structure of Jupiter's atmosphere, the dynamics of Jupiter's magnetosphere and the morphologic and geologic status of Jupiter's moons are investigated. Low energy proton and electron measurements in the magnetosphere, radio and plasma waves analysis, evaluation of the distribution of high energy protons and electrons in the Jupiter system are carried out. The gas distribution is analyzed by measurement of the molecular weight. The hydrogen/helium ratio in the atmosphere is measured. ESA

# 92 SOLAR PHYSICS

Includes solar activity, solar flares, solar radiation and sunspots.

For related information see *93 Space Radiation.*

No abstracts in this category.

# 93 SPACE RADIATION

Includes cosmic radiation; and inner and outer earth's radiation belts.

For biological effects of radiation see *52 Aerospace Medicine.* For theory see *73 Nuclear and High-Energy Physics.*

No abstracts in this category.

# 99 GENERAL

**N90-24217#** Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics.
**[REPORT OF RESEARCH ACTIVITY AT THE RESEARCH LABORATORY OF ELECTRONICS] Progress Report No. 131, 1 Jan. - 31 Dec. 1988**
Jonathan Allen, Daniel Kleppner, and Barbara Passero, ed. Jun. 1989 346 p
Avail: NTIS HC A15/MF A02

Topics addressed include: submicron structures; microstructural evolution in thin films of electronic materials; focused ion beams; surface chemical reactions; effects and applications of ultrashort laser pulse interactions with matter; semiconductor surfaces; optics and quantum electronics; statistical mechanics of surface systems and quantum-correlated systems; x ray diffuse scattering; semiconductor and other surface and intersurface studies; photonics; atomic, molecular, and plasma physics; electromagnetic wave theory and applications; radio astronomy; digital signal processing; cognitive information processing; optical communication; custom integrated circuits; neurophysiology and neural computation; speech communications; auditory psychophysics and physiology. J.P.S.

**N90-24218#** National Science Foundation, Washington, DC.
**NATIONAL PATTERNS OF RESEARCH AND DEVELOPMENT RESOURCES: 1989 Final Report**
Jan. 1989 72 p
(NSF-89-308) Avail: NTIS HC A04/MF A01

This is a summary of information from each sector of the economy engaged in supporting research and development (R and D). The National Science Foundation monitors the health of U.S. science and technology in these sectors, i.e., government, industry, academia, and other nonprofit institutions, because the nation's ability to compete effectively in international markets must be shared by all. Here, the National Science Foundation assembles and analyzes comprehensive measures of the financial and human resources that each of these sectors devotes to R and D activities. The 1989 data presented reflect estimates for R and D programs contained in the Federal 1989 budget as proposed by the Administration. Author

**N90-24219*#** National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
**RESEARCH AND TECHNOLOGY 1989 Annual Report**
1989 281 p Original contains color illustrations
(NASA-TM-100369; NAS 1.15:100369) Avail: NTIS HC A13/MF A02; 19 functional color pages CSCL 05D

The Marshall Space Flight Center annual report summarizes their advanced studies, research programs, and technological developments. Areas covered include: transportation systems; space systems such as Gravity Probe-B and Gamma Ray Imaging Telescope; data systems; microgravity science; astronomy and astrophysics; solar, magnetospheric, and atomic physics; aeronomy; propulsion; materials and processes; structures and dynamics; automated systems; space systems; and avionics. J.P.S.

**N90-24220*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**[TECHNICAL ACCOMPLISHMENTS OF THE NASA LEWIS RESEARCH CENTER, 1989] Annual Report, 1989**
1990 252 p Original contains color illustrations
(NASA-TM-102296; NAS 1.15:102296) Avail: NTIS HC A12/MF A02; 13 functional color pages CSCL 05A

Topics addressed include: high-temperature composite materials; structural mechanics; fatigue life prediction for composite materials; internal computational fluid mechanics; instrumentation and controls; electronics; stirling engines; aeropropulsion and space propulsion programs, including a study of slush hydrogen; space power for use in the space station, in the Mars rover, and other

applications; thermal management; plasma and radiation; cryogenic fluid management in space; microgravity physics; combustion in reduced gravity; test facilities and resources. J.P.S.

**N90-24221*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**LANGLEY AEROSPACE TEST HIGHLIGHTS, 1989**
May 1990 175 p
(NASA-TM-102631; NAS 1.15:102631) Avail: NTIS HC A08/MF A01 CSCL 05D

The role of the NASA Langley Research Center is to perform basic and applied research necessary for the advancement of aeronautics and spaceflight, to generate new and advanced concepts for the accomplishment of related national goals, and to provide research advice, technological support, and assistance to other NASA installations, other government agencies, and industry. Some of the significant tests that were performed during calendar year 1989 in the NASA Langley Research Center test facilities are highlighted. Both the broad range of the research and technology activities at the NASA Langley Research Center are illustrated along with the contributions of this work toward maintaining United States leadership in aeronautics and space research. Other highlights of Langley research and technology for 1989 are described in Research and Technology 1989 - Langley Research Center. Author

**N90-24222#** Joint Research Centre of the European Communities, Ispra (Italy).
**[ACTIVITIES REPORT OF THE JOINT RESEARCH CENTRE] Annual Report, 1988**
1989 95 p Original contains color illustrations
(EUR-12305-EN; ETN-90-96776) Copyright Avail: NTIS HC A05/MF A01

Specific research programs, exploratory research, scientific and technical support for the Commission of the European Communites, and work for external third parties are identified as the main activities. Main achievements and financial resources are detailed. ESA

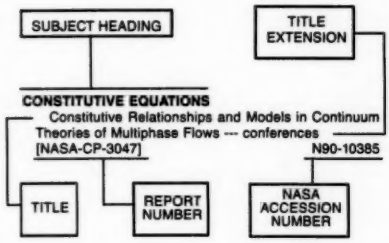
**N90-24223#** Technische Physische Dienst TNO-TH, Delft (Netherlands).
**[ACTIVITIES REPORT IN TECHNICAL-PHYSICAL RESEARCH] Annual Report, 1988 [TECHNISCH PHYSISCHE DIENST TNO-TH, JAARVERSLAG '88]**
1988 90 p In DUTCH and ENGLISH
(ETN-90-96771) Avail: NTIS HC A05/MF A01

Methods were developed for the measurement, calculation, and suppression of noise. Contributions were made in the field of thermal applications of solar energy. Building acoustics studies were performed. In the field of materials science, ceramics and glass products as well as glass technologies were developed. Optical inspection and measuring systems were developed. Instrumentation was developed in the fields of megabit chips, seismic and geological information system, digitized mapping, borehole scanners, and large scale measuring networks. ESA

**N90-24224#** National Aerospace Lab., Amsterdam (Netherlands).
**[ACTIVITIES REPORT IN AEROSPACE AND AERODYNAMICS] Annual Report, 1987 [STICHTING NATIONAAL LUCHT- EN RUIMTEVAARTLABORATORIUM, VERSLAG OVER HET JAAR 1987]**
1987 104 p In DUTCH Original contains color illustrations
(ETN-90-96774) Avail: NTIS HC A06/MF A01

The flow studies were focused on applied aerodynamic investigations in the fields of propeller propulsion, improvement of the aerodynamic efficiency, and aircraft configurations. The development of the measuring, registration and processing system for the Fokker-50 and Fokker-100 aircrafts was accomplished. Complementary nonlinear calculations were performed concerning the behavior in the Fokker-100 fuselage. Contributions were made to the preparation of the Italian x ray satellite SAX. Basic elements for a computer aided engineering infrastructure were developed. Calculations concerning the noise pollution of large aircrafts were performed. Technical equipment was manufactured for each of the above mentioned research fields. ESA

## Typical Subject Index Listing

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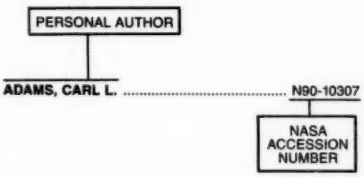


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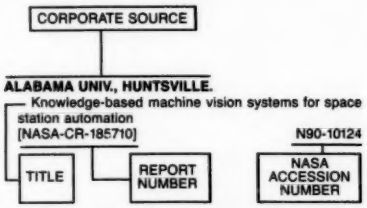


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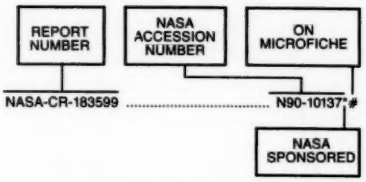


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AERE-R-13303-PT-2 ..... N90-23523 #
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AFATL-TP-90-05 ..... N90-23411 #
AFATL-TP-90-06 ..... N90-23357 #
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AFHRL-TP-89-67 ..... N90-23890 #
AFHRL-TR-89-42 ..... N90-23953 #
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AFIT/GA/ENY/90M-2 ..... N90-23473 #
AFIT/GA/ENY/90M-3 ..... N90-23746 #
AFIT/GAE/ENY/90M-1 ..... N90-23412 #
AFIT/GAE/ENY/90M-02 ..... N90-23389 #
AFIT/GCE/ENG/90M-2 ..... N90-23956 #
AFIT/GCS/ENG/90M-01 ..... N90-23609 #
AFIT/GE/ENG/90M-3 ..... N90-23608 #
AFIT/GE/ENG/90M-5 ..... N90-23400 #
AFIT/GLM/LSM/89D-14 ..... N90-23341 #
AFIT/GNE/ENP/90M-8 ..... N90-24147 #
AFIT/GOR/ENS/90M-7 ..... N90-23921 #
AFIT/GOR/ENS/90M-9 ..... N90-23610 #
AFIT/GOR/ENS/90M-15 ..... N90-23925 #
AFIT/GOR/ENS/90M-17 ..... N90-24184 #
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AFIT/GOR/ENY/ENS/90M-8-VOL-2 ..... N90-23892 #
AFIT/GOR/ENY/ENS/90M-8-VOL-3 ..... N90-23893 #
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AFOSR-90-0246TR ..... N90-23708 #
AFOSR-90-0264TR ..... N90-23599 #
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AFOSR-90-0284TR ..... N90-23483 #
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AFOSR-90-0307TR ..... N90-23998 #
AFOSR-90-0315TR ..... N90-23553 #
AFOSR-90-0321TR ..... N90-23509 #
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AFOSR-90-0349TR N90-24166 #
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AFOSR-90-0356TR N90-24019 #
AFOSR-90-0358TR N90-23873 #
AFOSR-90-0359TR N90-23885 #
AFOSR-90-0360TR N90-23872 #
AFOSR-90-0361TR N90-23886 #

AFWAL-TR-89-4001 N90-23558 #

AI-M-1083 N90-23952 #
AI-M-1175 N90-23992 #

AIAA-89-3619 N90-23466 #
AIAA-90-0337 N90-23366* #
AIAA-90-1899 N90-23404* #
AIAA-90-1901 N90-23406* #
AIAA-90-2319 N90-23518* #
AIAA-90-2386 N90-23416* #
AIAA-90-2452 N90-23591* #

AIM-1165 N90-23908 #
AIM-1176 N90-23951 #

ARAED-TR-89035 N90-23572 #

ARCCB-TR-90001 N90-23761 #
ARCCB-TR-90008 N90-23767 #

ARE-TM(UDT)-89114 N90-24054 #

ARFSD-TR-89014 N90-23606 #

ARL-TR-89-53 N90-23763 #

ARL/PSU/TR-90-002 N90-23995 #
ARL/PSU/TR-90-005 N90-23744 #

ARO-2249.5-EL N90-23632 #
ARO-6230-EE-02 N90-24156 #
ARO-21763.5-EG N90-23499 #
ARO-21822.3-MS N90-23482 #
ARO-22286.1-MS N90-23530 #
ARO-22779.3-MS N90-23526 #
ARO-22916.15-EL-A N90-24159 #
ARO-23617.13-MS N90-23529 #
ARO-23685.16-EL N90-24142 #
ARO-23757.16-PH-F N90-24111 #
ARO-23786.1-EL-F N90-23638 #
ARO-23910.16-CH N90-23718 #
ARO-24076.8-EG N90-23570 #
ARO-24139.12-EG N90-23689 #
ARO-24919.1-MA N90-24016 #
ARO-25325.1-EL-CF N90-23914 #
ARO-25396.14-MA N90-23765 #
ARO-25628.1-GS N90-23834 #
ARO-26224.1-GS N90-23617 #
ARO-26372.1-MS-CF N90-24110 #
ARO-26415.1-MS N90-24152 #
ARO-26759.1-RH-EG N90-23569 #

ASQB-CG-90-013 N90-23628 #

ATC-169 N90-23822 #

AVSCOM-TR-90-C-007 N90-23991* #
AVSCOM-TR-90-C-009 N90-23543* #

BAE-WES-RP-GEN-EMC-049-T2.2 N90-23626 #

BBC-RD-1989/12 N90-23592

BBN-7131 N90-23876 #
BBN-7173 N90-23631 #
BBN-7174 N90-23603 #
BBN-7176 N90-23604 #

BCRS-89-10 N90-23784 #
BCRS-89-11 N90-23785 #
BCRS-89-12 N90-23786 #
BCRS-89-24-PT-1 N90-23779 #
BCRS-89-25 N90-23854 #

BPA-89-29-VOL-1 N90-23816 #
BPA-89-29-VOL-2 N90-23817 #
BPA-89-31 N90-23818 #

BRDEC-2486 N90-23554 #

BRL-MR-3819 N90-23711 #

BRL-TR-3049 N90-23350 #
BRL-TR-3081 N90-23743 #
BRL-TR-3089 N90-24093 #

BR106069 N90-23542 #

CA-4/89 N90-23624 #
CA-5/89 N90-23590 #
CA-6/89 N90-23467 #
CA-6/89 N90-24139 #
CA-7/89 N90-23443 #
CA-8/89 N90-23458 #

CBIP-M-39 N90-23992 #

CERC-MP-90-1 N90-23823 #

CM-75 N90-23795 #
CM-77 N90-23830 #

CMS-TSR-90-18 N90-23771 #
CMS-TSR-90-20 N90-24047 #
CMS-TSR-90-22 N90-23772 #

CMU-SEI-89-TR-23 N90-23917 #

CONF-891119-121 N90-24148 #
CONF-891164-1 N90-23717 #
CONF-900602-6 N90-23596 #
CONF-900623-3 N90-23524 #
CONF-8908224-2 N90-23705 #
CONF-9002111-1 N90-24177 #
CONF-9004174-1 N90-23634 #
CONF-9006122-5 N90-23479 #
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CRDEC-TR-138 N90-23516 #

CRIF-MT-178 N90-23748 #

CRREL-SR-90-3 N90-23774 #

CRREL-89-20 N90-23775 #
CRREL-89-25 N90-23776 #

CSC/TR-89/6075-REV-1 N90-23447* #

CSG-120 N90-23980* #
CSG-124 N90-23401* #

CWI-AM-R8908 N90-24042 #
CWI-AM-R8909 N90-24107 #
CWI-AM-R8911 N90-24043 #
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CWI-BS-R8909 N90-23942 #
CWI-BS-R8910 N90-24005 #
CWI-BS-R8911 N90-24090 #
CWI-BS-R8912 N90-24045 #
CWI-BS-R8913 N90-24091 #
CWI-BS-R8914 N90-23943 #
CWI-BS-R8916 N90-24102 #
CWI-BS-R8917 N90-24095 #
CWI-BS-R8918 N90-24108 #
CWI-BS-R8919 N90-24096 #
CWI-BS-R8920 N90-24097 #
CWI-BS-R8921 N90-24060 #
CWI-BS-R8922 N90-24061 #
CWI-BS-R8923 N90-24062 #

CWI-CS-R8927 N90-24098 #
CWI-CS-R8928 N90-24063 #
CWI-CS-R8930 N90-23960 #

CWI-NM-R8905 N90-23659 #
CWI-NM-R8906 N90-23982 #
CWI-NM-R8907 N90-24038 #
CWI-NM-R8908 N90-24039 #
CWI-NM-R8909 N90-23941 #
CWI-NM-R8911 N90-24040 #
CWI-NM-R8913 N90-23983 #
CWI-NM-R8914 N90-24041 #

DAC-18 N90-23647 #

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DE90-009949 N90-23717 #

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DE90-010159 N90-23793 #
DE90-620561 N90-24149 #

DLC-EST-TD-032 N90-23361 #

DLC-EST-TN-030 N90-23359 #
DLC-EST-TN-031 N90-23360 #

DLC/COP-HER-TN-002 N90-23453 #

DLC/FLU-INT-TN-006 N90-23362 #
DLC/FLU-INT-TN-014 N90-23691 #

DMG-46/89 N90-23695 #

DMI-TR-90003 N90-23637 #

DNA-TR-89-25 N90-23547 #
DNA-TR-89-82 N90-23630 #

DODA-AR-005-742 N90-23684 #
DODA-AR-005-915 N90-23835 #

DOE/BP-63406/7 N90-23816 #
DOE/BP-63406/8 N90-23817 #
DOE/BP-63406/10 N90-23818 #

DOE/ER-0450T N90-23793 #
DOE/ER-13674/3 N90-24117 #
DOE/ER-14043/1 N90-23677 #
DOE/ER-45338/T2 N90-23525 #

DOE/NASA/21749-1 N90-23536* #

DOE/PC-90956/T9 N90-23671 #

DOT-CG-N-01-90 N90-23380 #

DOT-TSC-CG-90-1 N90-23380 #

DOT/FAA/AM-89/14 N90-23371 #
DOT/FAA/AM-90/3 N90-23895 #

DOT/FAA/CT-TN89/40 N90-23377 #
DOT/FAA/CT-TN89/42 N90-23379 #
DOT/FAA/CT-TN90/2 N90-23378 #

DOT/FAA/CT-89/32 N90-23369 #

DOT/FAA/DS-88/8 N90-23368 #

DOT/FAA/PS-89/4 N90-23822 #

DPG-FR-90-704-PT-2 N90-23833 #

DREA-TM-89/223 N90-23766 #
DREA-TM-89/227 N90-23498 #

DREO-TN-89-33 N90-23643 #
DREO-TN-90-1 N90-23481 #
DREO-TN-90-2 N90-23384 #

DREO-1017 N90-23615 #
DREO-1020 N90-23622 #
DREO-1021 N90-23621 #

DREP-TM-89-24 N90-23560 #

DRIC-BR-112707 N90-23607 #
DRIC-BR-112834 N90-23954 #
DRIC-BR-113133 N90-24054 #

DTRC/SSPD-90-175-14 N90-24056 #

E-4920 N90-23769* #
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E-5341 N90-23476* #
E-5381 N90-23754* #
E-5409 N90-23714* #
E-5422 N90-23991* #
E-5432 N90-23416* #
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E-5536 N90-23663* #
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E-5555 N90-23518* #
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ECAC-TR-88-001 N90-23612 #

ECL-89-12 N90-23568 #
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ECL-89-16 N90-23520 #
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ECL-89-19 N90-23704 #
ECL-89-22 N90-23519 #
ECL-89-008 N90-23667 #
ECL-89-009 N90-23521 #
ECL-90-02 N90-23703 #

EFI-90-33 N90-24123* #

EMV-88-30 N90-23657 #
EMV-88-42 N90-23658 #
EMV-88-54 N90-23665 #
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EO/MO-89-1 N90-23884 #

ERP-1027 N90-23809 #
ERP-1031 N90-23832 #
ERP-1048 N90-23806 #
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ERP-1053-VOL-2 N90-23356 #

ESD-TR-89-31 N90-23917 #
ESD-TR-89-146 N90-24160* #
ESD-TR-89-229 N90-24023 #
ESD-TR-89-235 N90-23613 #
ESD-TR-89-318 N90-23385 #

ETL-0556 N90-23383 #

ETN-90-96350 N90-23760 #
ETN-90-96444 N90-23542 #
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Includes aeronautics (general); aerodynamics; air transportation and safety; aircraft communications and navigation; aircraft design, testing and performance; aircraft instrumentation; aircraft propulsion and power; aircraft stability and control; and research and support facilities (air).

For related information see also *Astronautics.*

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| A03 | 15.00 | 30.00 |
| A04-A05 | 17.00 | 34.00 |
| A06-A09 | 23.00 | 46.00 |
| A10-A13 | 31.00 | 62.00 |
| A14-A17 | 39.00 | 78.00 |
| A18-A21 | 45.00 | 90.00 |
| A22-A25 | 53.00 | 106.00 |
| A99 | * | * |
| N01 | 60.00 | 120.00 |
| N02 | 59.00 | 118.00 |
| N03 | 20.00 | 40.00 |

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| E04 | 16.50 | 33.00 |
| E05 | 18.50 | 37.00 |
| E06 | 21.50 | 43.00 |
| E07 | 24.00 | 48.00 |
| E08 | 27.00 | 54.00 |
| E09 | 29.50 | 59.00 |
| E10 | 32.50 | 65.00 |
| E11 | 35.00 | 70.00 |
| E12 | 38.50 | 77.00 |
| E13 | 41.00 | 82.00 |
| E14 | 45.00 | 90.00 |
| E15 | 48.50 | 97.00 |
| E16 | 53.00 | 106.00 |
| E17 | 57.50 | 115.00 |
| E18 | 62.00 | 124.00 |
| E19 | 69.00 | 138.00 |
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* Contact NTIS for price quote.

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## ALABAMA

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Documents Department
Montgomery, AL 36193
(205) 279-9110 ext.253

**UNIV. OF ALABAMA LIBRARY**
Reference Department/Documents
Box S
Tuscaloosa, AL 35486
(205) 348-6046

## ARIZONA

**DEPT. OF LIBRARY, ARCHIVES, AND PUBLIC RECORDS**
Third Floor State Capitol
1700 West Washington
Phoenix, AZ 85007
(602) 255-4121

## ARKANSAS

**ARKANSAS STATE LIBRARY**
Documents Service Section
One Capitol Mall
Little Rock, AR 72201
(501) 371-2090

## CALIFORNIA

**CALIFORNIA STATE LIBRARY**
Govt. Publications Section
914 Capitol Mall
Sacramento, CA 95814
(916) 322-4572

## COLORADO

**UNIV. OF COLORADO**
**Norlin Library**
Government Publications Division
Campus Box 184
Boulder, CO 80309
(303) 492-8834

**DENVER PUBLIC LIBRARY**
Govt. Pub. Department
1357 Broadway
Denver, CO 80203
(303) 571-2346

## CONNECTICUT

**CONNECTICUT STATE LIBRARY**
231 Capitol Avenue
Hartford, CT 06106
(203) 566-4971

## FLORIDA

**UNIV. OF FLORIDA LIBRARIES**
Documents Department
Library West
Gainesville, FL 32611
(904) 392-0367

## GEORGIA

**UNIV. OF GEORGIA LIBRARIES**
Government Documents Dept.
Athens, GA 30602
(404) 542-8949

## HAWAII

**UNIV. OF HAWAII**
Hamilton Library
Government Documents Collection
2550 The Mall
Honolulu, HI 96822
(808) 948-8230

## IDAHO

**UNIV. OF IDAHO LIBRARY**
Documents Section
Moscow, ID 83843
(208) 885-6344

## ILLINOIS

**ILLINOIS STATE LIBRARY**
Federal Documents
Centennial Building
Springfield, IL 62756
(217) 782-5012

## INDIANA

**INDIANA STATE LIBRARY**
Serials Section
140 North Senate Avenue
Indianapolis, IN 46204
(317) 232-3686

## IOWA

**UNIV. OF IOWA LIBRARIES**
Government Publications Dept.
Iowa City, IA 52242
(319) 335-5926

## KANSAS

**UNIVERSITY OF KANSAS**
Spencer Research Library
Government Documents
Lawrence, KS 66045
(913) 864-4662

## KENTUCKY

**UNIV. OF KENTUCKY LIBRARIES**
Government Publications/Maps Dept.
Lexington, KY 40506
(606) 257-8400

## LOUISIANA

**LOUISIANA STATE UNIVERSITY**
Middleton Library
Government Documents Dept.
Baton Rouge, LA 70803
(504) 388-2570

**LOUISIANA TECHNICAL UNIV.**
Prescott Memorial Library
Government Documents Dept.
Ruston, LA 71272
(318) 257-4962

## MAINE

**UNIVERSITY OF MAINE**
Raymond H. Fogler Library
Govt. Documents & Microforms Dept.
Orono, ME 04469
(207) 581-1680

## MARYLAND

**UNIVERSITY OF MARYLAND**
McKeldin Library
Documents/Maps Room
College Park, MD 20742
(301) 454-3034

## MASSACHUSETTS

**BOSTON PUBLIC LIBRARY**
Government Documents Dept.
666 Boylston Street
Boston, MA 02117
(617) 536-5400 ext.226

## MICHIGAN

**DETROIT PUBLIC LIBRARY**
5201 Woodward Avenue
Detroit, MI 48202
(313) 833-1409

**LIBRARY OF MICHIGAN**
Government Documents
P.O. Box 30007
735 E. Michigan Avenue
Lansing, MI 48909
(517) 373-1593

## MINNESOTA

**UNIVERSITY OF MINNESOTA**
Wilson Library
Government Publications
309 Nineteenth Avenue South
Minneapolis, MN 55455
(612) 373-7813

## MISSISSIPPI

**UNIV. OF MISSISSIPPI LIB.**
Government Documents Dept.
106 Old Gym Bldg.
University, MS 38677
(601) 232-5857

## MISSOURI

**University of Missouri at Columbia Library**
Government Documents
Columbia, MO 65201
(314) 882-6733

## MONTANA

**UNIV. OF MONTANA**
Mansfield Library
Documents Division
Missoula, MT 59812
(406) 243-6700

## NEBRASKA

**UNIVERSITY OF NEBRASKA - LINCOLN**
Love Memorial Library
Documents Department
Lincoln, NE 68588
(402) 472-2562

## NEVADA

**UNIV. OF NEVADA-RENO LIB.**
Govt. Pub. Department
Reno, NV 89557
(702) 784-6579

## NEW JERSEY

**NEWARK PUBLIC LIBRARY**
U.S. Documents Division
5 Washington Street
P.O. Box 630
Newark, NJ 07101
(201) 733-7812

## NEW MEXICO

**UNIVERSITY OF NEW MEXICO**
General Library
Government Publications/Maps Dept.
Albuquerque, NM 87131
(505) 277-5441

**NEW MEXICO STATE LIBRARY**
325 Don Gaspar Avenue
Santa Fe, NM 87501
(505) 827-3826

## NEW YORK

**NEW YORK STATE LIBRARY**
Documents Sect. Cultural Educ. Ctr.
Empire State Plaza
Albany, NY 12230
(518) 474-5563

## NORTH CAROLINA

**UNIVERSITY OF NORTH CAROLINA AT CHAPEL HILL**
Davis Library 080A
BA/SS Department Documents
Chapel Hill, NC 27514
(919) 962-1151

## NORTH DAKOTA

**NORTH DAKOTA STATE UNIVERSITY LIBRARY**
Government Documents Dept.
Fargo, ND 58105
(701) 237-8352
In cooperation with Univ. of North Dakota, Chester Fritz Library
Grand Forks

## OHIO

**STATE LIBRARY OF OHIO**
Documents Section
65 South Front Street
Columbus, OH 43266
(614) 644-7051

## OKLAHOMA

**OKLAHOMA DEPT. OF LIBRARIES**
Government Documents
200 NE 18th Street
Oklahoma City, OK 73105
(405) 521-2502, ext. 252

**OKLAHOMA STATE UNIV. LIB.**
Documents Department
Stillwater, OK 74078
(405) 624-0489

## OREGON

**PORTLAND STATE UNIV.**
Millar Library
934 SW Harrison - P.O. Box 1151
Portland, OR 97207
(503) 229-3673

## PENNSYLVANIA

**STATE LIBRARY OF PENN.**
Government Publications Section
Box 1601
Walnut St. & Commonwealth Ave.
Harrisburg, PA 17105
(717) 787-3752

## SOUTH CAROLINA

**CLEMSON UNIV. COOPER LIB.**
Documents Department
Clemson, SC 29634
(803) 656-5174
In cooperation with Univ. of South Carolina, Thomas Cooper Library, Columbia

## TEXAS

**TEXAS STATE LIBRARY**
Public Services Department
P.O. Box 12927 - 1201 Brazos
Austin, TX 78711
(512) 463-5455

**TEXAS TECH. UNIV. LIBRARY**
Documents Department
Lubbock, TX 79409
(806) 742-2268

## UTAH

**UTAH STATE UNIVERSITY**
Merrill Library & Learning Resources Center, UMC-30
Documents Department
Logan, UT 84322
(801) 750-2682

## VIRGINIA

**UNIVERSITY OF VIRGINIA**
Alderman Library
Government Documents
Charlottesville, VA 22903
(804) 924-3133

## WASHINGTON

**WASHINGTON STATE LIBRARY**
Document Section
Olympia, WA 98504
(206) 753-4027

## WEST VIRGINIA

**WEST VIRGINIA UNIV. LIB.**
Government Documents Section
P.O. Box 6069
Morgantown, WV 26506
(304) 293-3640

## WISCONSIN

**ST. HIST SOC. OF WISCONSIN LIB.**
Government Pub. Section
816 State Street
Madison, WI 53706
(608) 262-2781
In cooperation with Univ. of Wisconsin-Madison, Memorial Library

**MILWAUKEE PUBLIC LIBRARY**
Documents Division
814 West Wisconsin Avenue
Milwaukee, WI 53233
(414) 278-3065

## WYOMING

**WYOMING STATE LIBRARY**
Supreme Court & Library Bldg.
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(307) 777-5919

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